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SANITY IN NAVAL ORGANIZATION.

SECRETARY MEYER'S PLANS FOR THE U. S. NAVY DEPARTMENT.

IN the pages of this Magazine for March and April last year there appeared some very plain words criticising the remarkable scheme of naval organization which was evolved by ex-Secretary Newberry. Those articles showed that the proposed system was unlike anything else in organization, either at home or abroad, in commercial or Government work. It was pointed out that this plan was subversive of all efficiency, and that without question it would have to be radically modified if not entirely swept away. It is worth remembering that, by the testimony of Mr. Newberry himself, the system was his own and was not the result of consultation with experts familiar with the conditions which were to be met.

When Secretary Meyer assumed office on March 4, 1909, he found the Navy in this state of disorganization, with dissatisfaction permeating more than 90 per cent of the commissioned personnel. The one corps which had been given everything by Mr. Newberry was, presumably, satisfied; but the rest of the Navy certainly was not, and this included the line of the Navy, which constitutes more than 60 per cent and is responsible for the actual handling of the vessels in service as well as for the design and installation of the machinery. Mr. Meyer very soon became cognizant of the exceedingly unsatisfactory condition of affairs, but, unlike his predecessor, he did not attempt to remedy things out of his own inner consciousness and without consultation with experts. On the contrary, he organized a Board representing all branches of the service, to consider matters carefully and make a report. In view of all the circumstances, and of what the corps

favored by Secretary Newberry had to lose, it could not be a matter of surprise that the consultations of this Board resulted in a divided report. Consequently Mr. Meyer appointed several other Boards to consider the necessities of the service, the last of which was presided over by Admiral Swift, and hence is known as the Swift Board. This Board made a report some months ago, and after very careful consideration and conference with the President, Secretary Meyer put its provisions in force as of December 1, 1909.

The report of the Swift Board was very comprehensive and covered the organization of the Department as well as of the Navy Yards. The daily newspapers have given in considerable detail the action taken by Mr. Meyer in execution of the recommendations made, and have commented on it at length, for the reason that the Navy is now recognized as one of the vital factors in the National strength, with expenditures running to more than one hundred millions annually, so that every patriotic citizen of the United States is coming to realize that as a part owner he has a vital interest in having the Navy operate with the highest possible efficiency. The extended publicity which has been given to the scheme will render it unnecessary for us to go into the points in great detail.

We felt it a duty last March and April, although with much sorrow, to point out that the scheme which was being forced upon the Navy (against the views of most of the personnel) was wrong and could only bring about inefficiency and waste. It is now a duty, but a very cheerful one, to comment very cordially upon the system which Secretary Meyer has established, based upon the report of the Swift Board, and to say that we believe the general principles of the new system are correct; and that if it is administered in a spirit of reasonableness, which will permit of modification where modification is found necessary, a high degree of efficiency and economy are the assured outcome of its operation.

With respect to the navy yards, the Meyer plan recognizes the point which was made in our article of last April—that there is a clearly defined difference between the hull and the machinery departments. As a consequence, the work at the navy yards is to be divided into two grand divisions, one having to do with the hulls and the other with the machinery of the ships. Public works, under the civil engineer, will form a separate division, reporting to the commandant. As will be remembered, the Newberry plan placed all the work in the navy yards under the constructor, (who was to be known as the "Manager") and magnified his office to such an extent that the com-

mandant became a mere figure head. The Meyer plan puts things right by making the commandant the general manager of the yard and the captain of the yard an executive assistant, and placing the heads of the engineering and hull departments each in responsible charge of his own class of work. Inasmuch as this is the system which prevails in all private shipyards in the United States, and in the private and Government shipyards abroad, it has been thoroughly proved by years of test and will undoubtedly give efficiency.

The new plan also provides for a system of accurate cost accounting, which has been devised by a firm of expert public accountants, and has been tested out by several months' use at the Boston Navy Yard. This is undoubtedly an excellent scheme, and one which has long been needed. We have nothing but commendation for this, but we are afraid, to judge from some of the newspaper comments, that more will be expected from this cost accounting than is likely to result. One of the papers stated that the pay corps of the Navy estimated an annual saving from this cost accounting equal to the cost of a battleship. Remembering the result of the consolidation of store houses (which has been administered for years by the pay corps) and how instead of reducing expenses it has increased them, we can hardly be unduly optimistic as to any great saving as a result of the cost accounting. It is, however, important that there should be correct knowledge of what navy-yard work does cost, and this knowledge may have an important influence in determining distribution of work between the several yards or between the yards and outside manufacturers. It may also be said that the principle involved—namely, that of placing the determination of costs in other hands than those that do the work—is good business practice. Therefore, even though the cost-accounting system *per se* may not be expected to cause much, if any, diminution in the total expense, the knowledge gained will be well worth all it costs.

This Magazine has for years insisted upon the fact that the modern navy is essentially an engineering affair, created by engineers and depending upon them for its efficiency. The line of the Navy having been charged with engineering work by the Personnel Law of 1899, it was most important that this prominence of engineering should be recognized by the Department. While the necessities of ship work had been training many of the officers, it remained for Secretary Meyer's report of this year to give the first cordial and hearty endorsement of the true position of engineering since the time when Ex-President Roosevelt as Assistant Secretary stated that "on the

modern war vessel, every officer has to be an engineer, whether he wants to or not." Secretary Meyer says:

> Almost every act of the line officer aboard ship has to do with machinery and engineering. In his duties in the engine room, in turrets, and at guns, and in electricity he is constantly in charge of the operation of complicated machinery. By the training and direction of the men handling the different machines and engines and in his deck duties he is trained in administration. This continuous performance of engineering duty has fitted and is fitting officers for the duties of senior engineer of our vessels, with the result that the motive machinery of the fleet is in excellent condition.

Mr. Meyer realized the force of the Swift Board's report that to secure the most thorough training of the line in their engineering work, it was necessary that they should have charge of the engineering work on shore as well as at sea, and further that this engineering work on shore would certainly be most efficiently performed when administered by the officers who had gained experience with machinery at sea. This requirement for highest efficiency both on shore and at sea is met by the new system, which divides the work at the navy yards and places the engineering work in charge of men who have been educated and trained as engineers.

The Secretary in his report alludes to the fact that as all the engineering now devolves upon the line of the Navy, it is necessary to make adequate provision for a supply of skilled designers to take the place of the present highly trained engineer officers when they retire; and it is further gratifying in this connection to note the compliment he pays these officers by saying "their duties have been ably performed." The provision for training designers is made by the establishment of a post-graduate school of marine engineering at the Naval Academy. Work has already been begun, and we are in a position to know that so thoroughly is the importance of this work appreciated by patriotic engineers of the highest standing that a projected course of lectures by non-resident engineers has already secured the services of such men as Admiral Melville, Mr. George Westinghouse, ex-Chief-Engineer Walter M. McFarland, Dr. F. R. Hutton, and others of equal prominence.

The details of the new system as affecting engineering are so heartily in accord with the views expressed in this Magazine that we might well be gratified to think that these views were given some weight in the deliberations which preceded and led up to the changes now made. At all events, as we said at the start, Secretary Meyer's plan meets with our hearty commendation and best wishes. We feel

encouraged also to know that the Secretary and his advisers have approached the subject with an open mind and have given it the most careful consideration, and that they will not hesitate to make any modification for which experience may show the necessity. This is the only proper spirit to secure efficiency. If the head of a great department takes the position that having once approved a plan he stamps it as perfect and will thereafter consider no modification, he absolutely assures inefficiency. The attitude of the present Administration appears to be exactly the opposite of this, without false pride about personal views, and with a readiness to accept advice and suggestions, to give them consideration, and to utilize them if found advisable.

Besides the navy-yard organization the Secretary has put in force a very important change at the Department; that is, the appointment of four flag officers as personal aids to advise him with respect to matters coming within the purview of the four great divisions into which the work of the Department naturally falls, viz., operations of the fleet, personnel, *materiel*, and inspection. The Board of Construction has been abolished, and its functions are to be taken over by the General Board whose membership is somewhat changed by including several of the Secretary's personal aids.

At first sight it might seem that this creates a General Staff, although under another name, and of course it is possible that in time the General Board may evolve into a General Staff. It is to be noted, however, that while the personal aids have supervision of the classes of work mentioned, they have no executive authority, their function being to advise the Secretary with respect to work in these lines, so that he will not be compelled to depend entirely on his own judgment in passing on recommendations from the Bureaus, but will have the benefit of expert responsible advice. As we understand it, the Bureaus themselves will still have the same direct access to the Secretary that they have always had. The only difference is that there is now an officer of high rank and long experience, who is responsible for the advice he gives and yet is not charged with the execution of the work he criticises, on whom the Secretary can depend for assistance. To a certain extent this is somewhat in line with the comment of a writer in this magazine about a year ago,* who took the view that a General Staff was not necessary and indeed was undesirable. To the argument so frequently advanced that the Secretary is a non-technical man and therefore could not pass upon technical questions intel-

* The Effectiveness of the Bureau System in Naval Organization. THE ENGINEERING MAGAZINE, November, 1908, page 161.

ligently, it was answered that the great executives of many great railroads and manufacturing establishments are not technical men, but that when they have the requisite executive ability, they know how to get at the essential points and to decide them wisely. Secretary Meyer's plan has shown one of the methods whereby such a competent executive will secure the adequate view of the essential points—viz., by these aids, who are experts and can advise him so that he will be able to reconcile the conflicting interests of Bureau chiefs, each of whom is sincerely conscientious in believing that what he recommends is for the highest interests of the service, even if it is incompatible with what another, equally conscientious, wants to do.

One of the sad things in connection with the Roosevelt Administration, which on the whole was so highly beneficient to the country, was the fact that with his marvelous ability and courage the ex-President was very impulsive. We have been told by those who have had the privilege of intimate association with him that his keenness in grasping a situation was extraordinary, but that unfortunately when a case was cleverly presented to him, he would often jump to the conclusion that he knew the whole subject when he had heard only the one side. This was the case with the Newberry plan of naval organization. There can be no doubt that if the President had had time to hear all sides of the question (and indeed if it had not been for the "Reign of Terror" instituted by the ex-Secretary, who threatened to court-martial any officer who opposed his plan), Mr. Roosevelt would never have approved such a ridiculous and amateurish scheme.

The question may be raised by impartial critics whether the new system does not unduly subordinate the Bureau of Construction, which the Newberry scheme made the controlling factor in matters of *materiel*. If it does, it would only be a swing of the pendulum from one side to the other. But we do not so understand the Secretary's plans. Apparently the Bureau chiefs have the same direct access to the Secretary as hitherto, and the same responsibility for their work. The new system does reduce the scope of Construction's work from what it was under the Newberry scheme, but that is only because, under that scheme, its powers were improperly and unduly increased. There is ample scope for all the ability of the talented chief of that Bureau, and his assistants, in the legitimate work which comes to them and of which they are assured in this new system; and we have no doubt that they will make an even better record than hitherto, now that they are relieved of uncongenial and unfamiliar duties.

A very commendable feature of the new plan is its frank recognition of the fact that, in general, the navy yards are not manufacturing concerns but repair plants, and that the organization must fit this condition. A very great deal of harm is done in this world by extending methods good in themselves beyond their natural limits. We have seen much of this in the last ten years among the multitude of projected and promoted "consolidations," all made with the alleged object of securing economy in manufacture and administration. This result did come in a few cases, but even "the man on the street" now knows that the real object of many of these consolidations was to work off a lot of watered stock on a too innocent public. The Newberry scheme was a case of consolidation where it was not only ill-advised but actually harmful. There can not be the slightest doubt that it would have failed completely at the first real test, just as the inordinate amount of red tape attending purchases was completely cast aside under the stress of the Spanish War. It should never be forgotten that the Bureau of Equipment and of Steam Engineering were born of the exigencies of the Civil War, and it need not cause surprise if, as time goes on, Secretary Meyer should find it necessary, in the interest of expedition and efficiency, to differentiate still further than he has done. Fortunately, he is after results and not the riding of a hobby, so that he is perfectly free to do whatever experience shows to be desirable.

Therefore, while we fully agree with the maxim "*De mortuis nil nisi bonum,*" we are reluctant to agree with one portion of the Secretary's report. This does not relate to the merits of the new system—but is only that portion where he speaks of the Newberry craze for consolidation as a step in the right direction. To our notion it was a disaster, and the only conceivable way in which it can be considered as doing good was in its resemblance to some devastating conflagration which wipes out the established order, and thus compels a rehabilitation in the course of which improvements are made. This was true of Baltimore and San Francisco; but that such a drastic method is not necessary was proved by Baron Haussmann's improvements in Paris, effected without burning the whole city. Of course, the stress of political exigency makes diplomatic expression necessary; Secretary Meyer is to be commended for his courtesy to his predecessor. The great contrast, however, between the painstaking care he has taken to be sure the new system is right, and his predecessor's indifference to expert advice in the inception of the nightmare which is now happily ended, can not be too strongly emphasized.

Besides the specific things that are accomplished by the adoption and carrying out of the Swift Board's report, Secretary Meyer's action has done an incalculable good to the Navy by restoring the feeling that officers can count on common sense being the rule in the Department's plans and decisions. The injury done to the *morale* of the service by the vagaries of the Newberry *régime* can be appreciated only by those who were in very close touch with naval officers. If a man can be sure that good work and efficiency will secure recognition, he is glad to devote himself to his task with energy, but when he finds that a lifetime of the most splendid devotion is ignored, as happened under the preceding administration, he can be excused for feeling that he might as well retire. That so many capable officers continued faithfully to perform their duty in spite of all such discouragement is a splendid testimony to their pride in their profession and their love of the service.

It was hoped and believed that with the advent of a President who had been trained as a judge, the spirit emanating from the Chief of the Administration would actuate his cabinet officers and matters of serious moment would be given careful study and adequate consideration, before action was taken involving such serious matters as the organization of a great Department. This anticipation has not been disappointed, and the United States is to be congratulated on the direction of the Navy Department by such a chief as Secretary Meyer, whose actions thus far have shown a splendid grasp of the situation and executive ability of a very high order. If his future conduct of the office should be along the lines which have been followed thus far —and we sincerely hope that this will be the case—we predict that his name will go down as that of one of the great Secretaries and great administrators in the history of the United States Navy.

THE PROBLEM OF THE MINOR EXECUTIVE.

By H. Keith Trask.

Mr. Trask takes up a problem of increasing importance in modern organized industry, and voices effectively an opinion which will demand the careful attention of those concerned in the management of large enterprises.—THE EDITORS.

THE era in which we live is one of change in every condition of our existence. Our ambition today reaches out toward big things; we achieve a compactness and efficiency such as our fathers never dreamed of. Our transportation facilities, our personal comforts, and all the characteristics of our modern life have been completely revolutionized.

Nowhere is this revolution more marked than in the organization and conduct of great industries. Fifteen years ago an industrial plant employing five-thousand men was a rarity, and was considered a remarkable example of business enterprise. Today we have industrial concerns numbering fifty-thousand men on their pay rolls. These enormous organizations, commonly called trusts, and frequently depicted by the cartoonists as benevolently smiling, elderly gentlemen with plethoric waistcoats covered with dollar marks, have been built up by the exigencies of the evolution of modern business. It is not within the province of the present discussion to consider the influences that have brought about these changes in organization. It is essential to our argument, however, to point out how vastly the problem of executive control differs in a concern employing five-thousand men, from that in one employing twenty-five thousand.

The organization of the average trust has been effected by the consolidation of a number of small concerns producing similar or kindred materials, be they steel or sugar, under one management. Some one of the heads of the smaller concerns is usually chosen, for the various qualifications that fit him therefor, as the chief executive of the large organization. Similarly we have concerns that, in the unparalleled industrial prosperity of recent years, have suddenly grown to three or four times their former size in a brief space. The executive head of such a concern is in the same position as the newly appointed head of a consolidation of small concerns. In either case,

the chief executive finds himself confronted by an entirely new set of conditions and vastly increased responsibilities.

Under the old *régime*, when a plant was small, it was possible for the chief executive to keep all the details under his personal supervision, and he usually did so. The average factory manager of that day considered it essential that he should be so intimately in touch with the work under his command as to be able to answer every question of detail, and that he should keep himself thoroughly posted on the minor conditions of his output. Such familiarity with routine detail is impossible in the large organizations of the present time; nor is it desirable in the executive chief. When he is brought face to face with the new conditions he realizes at once that he must have trustworthy lieutenants to carry the burden of routine, and thus to leave him free to consider the broad general problems of his command, and to act as judge or umpire in all questions in dispute. It is in this initial act that so frequently the fatal error is made. Realizing fully the necessity for providing himself with efficient subalterns, the chief executive nevertheless fails to pick the proper timber. Laying aside the evils of nepotism that too frequently creep in, we often find men chosen for subordinate positions of authority and responsibility who are not fitted either by education or previous training to carry the load successfully. It is but natural for a man suddenly placed in the position of our new chief executive to turn to his subordinates, or fellow workers of former days, for his trusted assistants. In most cases, these are men who have been trained in the old school and are cautious and conservative. They have been so busy keeping "the boss" posted on detail under the old *régime* that they have not had time to observe the growth and changed conditions around them. When such men are made heads of departments in a large modern concern, they find themselves in deep water and commence to worry, with the result that, too frequently, they suffer a nervous breakdown before middle life.

It is quite obvious that when such a choice is made by the chief executive disappointment must ensue. Instead of being able to lean upon the subordinate, he is compelled to decide a number of trivial, detail questions that should never come to his notice at all, and his attention is distracted from the broad and important problems of his position. He naturally places all the blame upon the shoulders of the individual who has been found wanting, when, in fact, the fault lies in the choice of the instrument.

In this dilemma, the chief is apt to turn to a technically educated man. A number of such young men are usually to be found in the

employ of any large corporation, and one with a reputation as a hustler is promoted to the vacant position of responsibility. The attitude of mind of the average old-line man, who has been educated chiefly by hard knocks, toward the technical graduate is curiously complex. It is apt to be a mixture of contempt and secret and involuntary envy. That there is a tacit admission of the advantages of a technical education is shown by the unanimity with which the old-line shop-educated men agree in sending their sons to college.

When, therefore, the shop-educated man promotes a young technical man to a position of responsibility he is apt to expect too little or to exact too much. The young man may be allowed absolutely no scope for the display of his individuality, or he may be expected to achieve the impossible because he is college-bred. On the other hand when he is thus promoted, the technical man may lose his sense of perspective. He has no traditions behind him, and is full of all modern theories. To him his chief appears old-fashioned and behind the times, and he is apt to criticise, not openly perhaps, but by implication. This attitude of mind is productive of as evil results as that of the old-line employer. It breeds dissatisfaction on both sides as prolifically as the employer's lack of confidence.

If the parties in interest are men of good fundamental common sense, their diametrically opposed standpoints will gradually harmonize, and in the end a successful and cordial relationship will be established. Mutual forbearance and honest effort to establish harmony are absolutely essential to a proper relationship.

The ideal industrial subaltern is *rara avis*. Happy is the executive who possesses such an one. He must be first of all a good subordinate, who will obey without criticism or question, or who can, when necessity arises, have an honest difference of opinion with his chief without antagonizing him. He must also be willing to make personal sacrifices of time to his employer without giving the impression of unwilling compulsion. Lastly, and chiefly, he must have the tact and discretion which will enable him successfully to handle those who are placed under his control without friction or the necessity for the constant display of restraining authority, and with strict judicial impartiality. These things are not instinctive gifts with every man. Some few there are who are seemingly born executives, but the majority of men holding responsible positions have had to learn their lesson in the bitter school of experience. There are so many ways in which power may be unconsciously abused and grave injustice done that even with his attention rivetted on this danger, the average man will make frequent errors. The question of favoritism is a grave one

for the young executive to face. When it is practiced openly nothing is more subversive of discipline. The greater danger here lies, however, in unconscious favoritism. It may be that one particular individual far exceeds his fellows in the accomplishment of his task. Naturally there is an involuntary tendency to show partiality for such an one. This partiality once shown, all the other workers feel there is not much use in trying to excel since the credit is all to go to one individual, and a discontented force is the immediate result. In just the same way, though even more strongly, may a bias against an individual be established. It frequently happens that some otherwise efficient employee may possess an unfortunate personality in some respects. He may be insolent in bearing without such intent, or in some more intimately personal way offensive, so that subconsciously the mind of his superior is influenced against him, to his detriment. We must assume subconscious influence in either of the cases cited above since it is very evident that the man who in his official capacity will knowingly prefer one man above another, or decide a dispute not on its merits, but in accord with his personal bias, is utterly unfit to exercise authority over his fellow men.

Another essential qualification for a leader of men is the ability to understand the thoughts and feelings of those under his control—in brief, to sympathize with them. In opposition to this theory, the point can be made that many of the great leaders of history have had but small regard for those whom they ruled. We can say in answer to this argument first, that those leaders were military chiefs holding power of life and death, while the industrial leader, although holding the power to deprive a man of the means of livelihood for a time, nevertheless is to a considerable extent dependent upon the good will of his employees to get efficient service. Second, that the conditions of life are materially altered today from what they were in the time of Napoleon, for instance, and that neither military or industrial armies can be ruled today as they were then. Now each individual is an entity with rights of which he is apt to be jealous, and with feelings which we are bound to respect. In early days, the workingman was a serf who belonged bodily to his master. This condition was perpetuated in the technical industries up to very recent times, comparatively speaking, in the apprentice system whereby a youth was bound to his master until the time of his majority. The old theory of the driver as the successful executive falls flat today. The workingman of the present has been educated sufficiently to be thoroughly self-respecting. In order, therefore, to rule him successfully we must be enabled to approach any issue from his point of view, and to

deal with him from the standpoint of sympathetic understanding. A successful educator once remarked that "the keynote of maintaining discipline in a boarding school is knowing what not to see." The same principle applies to the handling of men, but in addition, we must know what to see.

It may be urged that the practical man who has been a workman himself is most apt to possess these characteristics, but this is by no means the case. Especially if he has been previously employed among those over whom he is placed, it is impossible for such a man to attain the judicial attitude of mind. It is also practically impossible for this man to avoid favoritism. Oftentimes, he is connected by blood ties with those who come under his control, and he will inevitably be swayed by considerations of previous friendship no matter how hard he may strive not to be. Deficiencies of early education may be sufficiently overcome to enable him to cope successfully with new conditions, but the old ties and old habits of mind are almost impossible to shake off. On the other hand, the objection will be urged that a young man fresh from the technical school cannot possibly possess the necessary qualifications, and this is admittedly true. The solution of the problem must therefore lie in the combination of the qualifications that are comprised in the advantages of a technical education with a sufficient experience as a private to enable the individual to become an efficient officer.

At this point, we meet a difficulty that has not as yet been entirely overcome. The average technical graduate is unwilling to commence at the bottom and work up. This unwillingness arises from a number of causes. With many young men, a distaste for manual labor involving dirt and more or less personal discomforts is the determining factor. By far the larger number is deterred by the prospect of inadequate financial reward later on. Even though the period of apprenticeship be short, and the pay during that period fair, the feeling is quite often observed among the young men that upon the termination of the probation period, they are shouldered with the responsibility of command without corresponding advance in remuneration. Looked at in one light this consideration is a mercenary one, but if viewed with perfect fairness, it is natural that such should be the case. Many employers feel that a young man should consider himself as gaining a part of his remuneration from the experience he acquires, but it would seem that there is a point where the mere acquisition of knowledge and experience ceases and the individual commences to return full value for what he receives. It would seem as though the termination of the apprentice period should mark this

point. If a man be sufficiently able to be entrusted with considerable responsibility, it should follow that he be paid in proportion to his increased earning power. The knowledge that he is learning something every day is not adequate compensation to a man for the sacrifice of much time and the worry incident to increased responsibility.

It is to this consideration of fair and adequate reward for the middle man, the minor executive, that the employer will have to give an increasing amount of attention in the future if he is to get efficient men. The workman has his labor organization to look after his interests. The employer is well able to take care of himself; but his representative, the subaltern, is helpless. Manifestly he cannot join the union of the men he controls, for even should they permit it, it would be utterly subversive of discipline. Equally he cannot form a union of his own without peril to his loyalty to his employer. He is, therefore, dependent on the sense of fairness of the employer for adequate compensation. So long as the prevailing tendency is to exact more than a fair return, it will be impossible to persuade an adequate number of efficient men to fill the minor positions. If the employer is to meet the conditions of the future, he must have efficient subordinates; and to get efficient subordinates, he must pay them. It is because this has been realized in the past in but a dim, short-sighted sort of way, that so many unfit men have been promoted to responsible positions. To a short-sighted employer, it seems unnecessary to pay the compensation demanded, or rather expected, by a technical man when a shop man will hold the same position for less money. What he does not realize is, that it takes more shop-trained men to cover the same ground.

The great desideratum is, therefore, to impress upon the mind of the average large employer of labor, the necessity for a thorough and sympathetic understanding between himself and his subordinate officers. The broader-minded executives of today appreciate this necessity, and are acting upon their perception of the need. The majority, however, requires to be waked to the conditions that confront us. A wofully small percentage of our total yearly number of technical graduates turns to the shop. By far the greater number turn to the business end. We are today confronting much the same condition in the case of the subaltern officers, as we did ten years ago in the case of skilled mechanics. That we are frantically attempting to remedy this well-nigh fatal neglect, the various elaborate apprenticeship systems throughout the country bear witness. Let us hope that there will be a more timely awakening to the demand for properly trained minor executive officers.

MAKING STEAM WITH MIXED FUEL.

By Arthur S. Mann.

Mr. Mann's article is a practical treatment of a practical problem in boiler-room economy, so explicit as to be available for working directions and so broad as to be of interest to a large number of power users.—THE EDITORS.

IT is not necessary to make a thorough mixture in order to burn two kinds of fuel at once. There are many boiler rooms burning coal where it is possible to burn a mixture of fuels with advantage. In the Eastern section of the United States the best grades of soft coal are expensive, and in many places there is a near-by supply of low-grade coal, either hard or soft, which is much cheaper. While loads are heavy it is not possible to change from one fuel to another on a given grate, and with a given fire chamber, because the cheap coal cannot be burned fast enough where good soft coal is the usual fuel. On the other hand, if a furnace is proportioned for low-grade coal, there is too much grate surface for a proper fire with good coal. If, however, there is a period of heavy load, lasting as it usually does, not more than an hour or two, with an average less than 40 per cent of this heavy load, the expensive coal can be used for that time and the cheaper coal in varying proportions for the lighter loads.

Five years ago some overload boiler trials were conducted for the purpose of determining the fuel costs with various mixtures of hard and soft coal, and the following table shows results based upon 1000 pounds of equivalent steam (evaporated from and at 212 degrees F.).

Fuel.	Cost of 1000 lb. equivalent evaporation	Relative costs, per cent	Per cent rating developed
All soft coal.....	$0.134	100	153
1 part hard and 2 parts soft coal.....	0.1269	94.6	141
1 part hard and 1 part soft coal.....	0.1180	88	147
2 parts hard and 1 part soft coal.....	0.1160	86.5	132

These trials were made upon a 500 horse-power water-tube boiler, fitted with underfeed stoker. The low-grade anthracite was charged at $1.85 per ton and contained about 12,000 B.t.u. Run-of-mine bituminous cost $3.05 and contained about 13,800 B.t.u. per pound.*

* At the time these trials were made, hard coal cost $1.50 and soft coal $2.85 per ton. The computations are made as stated in text so that the results may be compared with figures in later tables.

The furnace was designed for burning bituminous coal and has proven itself efficient for that work, taking severe overload readily. On the other hand, considerable effort is called for in working fires and the process of cleaning fires is laborious. The low-grade anthracite coal makes the clinker and ash more workable and more porous; probably this explains part of the advantage in money, secured by using the mixture.

High furnace efficiency is desirable, but the price of the coals has more to do with the topic under discussion, and cost per unit weight of steam is the all-important item regardless of efficiency.

When the first attempt was made to burn two kinds of fuel at one time the coals were mixed with a shovel on the fireroom floor, just as thoroughly as is cement and sand for mortar. This process is laborious and the labor cost affects the gain in fuel cost. The method of handling was then modified in several stages; (1) a shovel full, say 15 pounds, first of one kind and then of the other was thrown into the stoker hopper; (2) a barrow load of 100 pounds of one kind alternated with 100 pounds of the other; (3) a full hopper of 300 pounds of one kind alternated with 300 pounds of the other.

Any one of these three latter methods answers as well as the thorough mixture, though charges of 300 pounds are quite the limit on the furnace in question. Any greater amount of hard coal deadens the fire, for a part of the office of soft coal lies in serving as a kindler for the hard coal, and an excess of anthracite can blanket a fire just as an excess of green coal can put out a fire of kindling wood in a house stove. There is a certain degree of mixing taking place, probably a considerable one, as the fuels pass through the hopper and coal feeder. Such mixing is sufficient for the purpose.

An application of this method of coal burning was installed some time ago where there are twenty-two 500 horse-power boilers. There was an overhead bunker fed with two separate lines of bucket conveyors. The boilers were below, fed with spouts in the usual way. In order to adapt the coal systems to the two-kind process, a concrete partition was built in the bin from end to end, so that low-grade coal could be stored in one bin and high-grade in the other. Each boiler was then provided with a spout to both bins, which made necessary the construction of one new spout only to each boiler. Figure 1 shows a cross section of the fireroom. Figures 2 and 3 are photographs of the plant in operation.

Each fireman draws coal as he is instructed by the head fireman, usually in less than 100-pound lots of one sort of coal. From 4

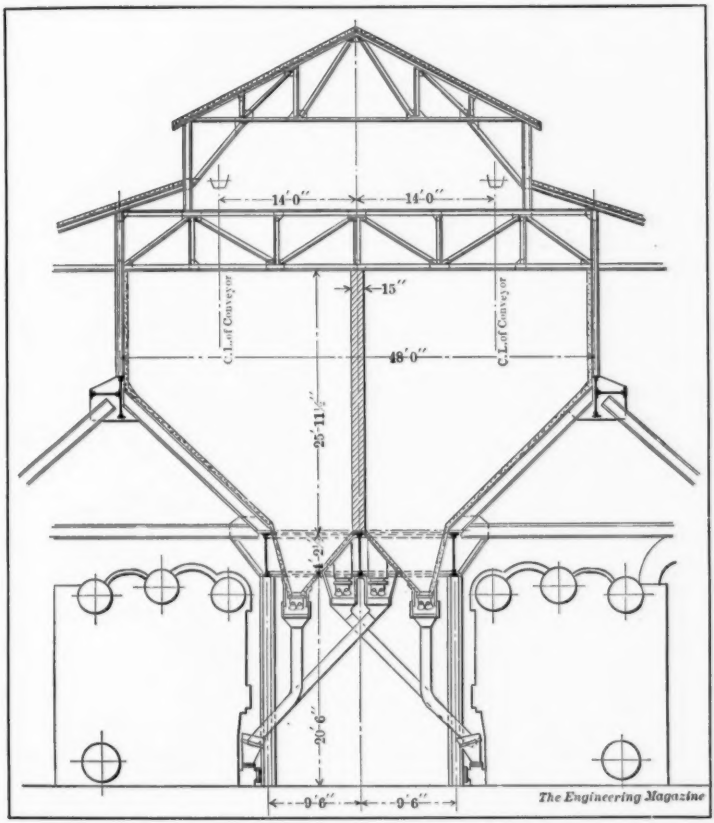


FIG. 1. CROSS SECTION OF FIREROOM AS ARRANGED FOR BURNING MIXED FUEL. A concrete partition divides the fuel bunker, giving separate storage for low-grade and high-grade fuel.

o'clock to 7 p. m. the proportion of hard coal is small. It increases to a maximum during the light load of the night, and varies to suit the load during the day. For the year the hard coal is about 40 per cent of the soft coal. During 1908, 48,000 tons of fine anthracite coal were burned and 77,700 tons of bituminous, the latter including a very large amount for standing by and banking. These proportions would be different for a different grate. The grates in example quoted were designed for rapid combustion rates (30 to 50 pounds per square foot per hour) and certain grades of hard coal restrict the burning rate.

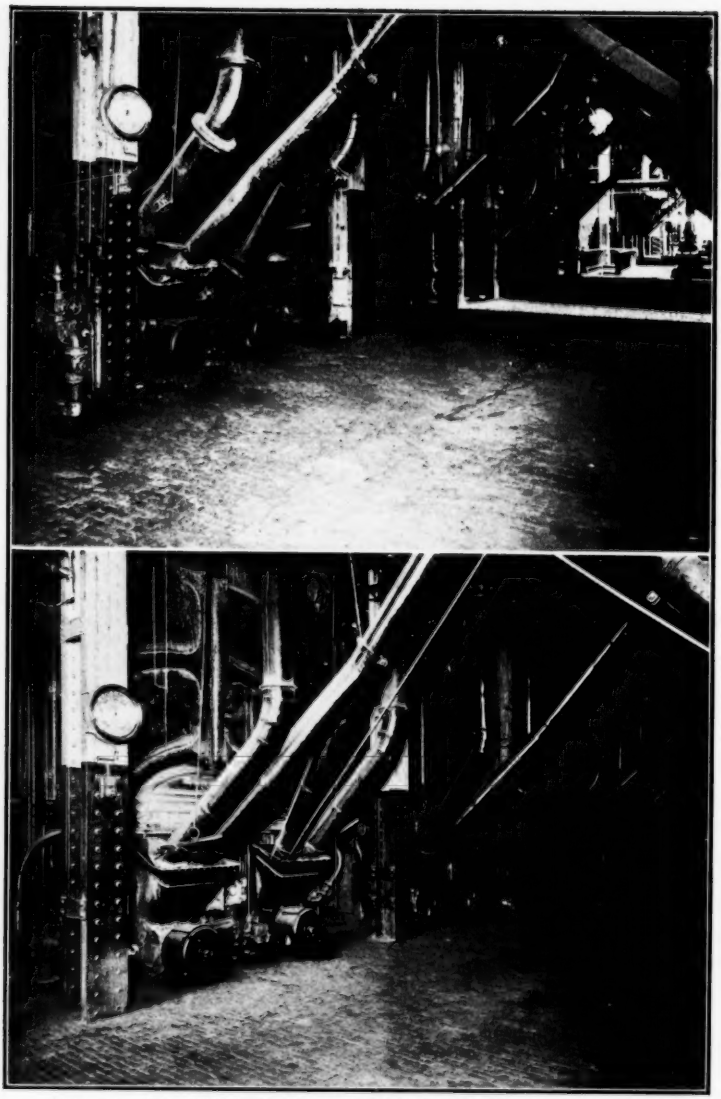


FIG. 2, 3. THE TWO SIDES OF A FIREROOM OPERATING ON MIXED FUEL.

After the plant had been in operation about three years it was found necessary to enlarge the steam-generating equipment, and four 600 horse-power water-tube boilers were added. These boilers were fitted with a gravity underfeed self-cleaning stoker, easily operated and capable of taking large overload. This new equipment added about 4,000 horse power to the peak-load capacity, and it immediately became necessary to find out the suitability of cheap coal in any proportion as a fuel. The stokers were bought as soft-coal burners, and hard coal was an experiment on the grates. Figure 7 is a photograph of one unit.

A series of boiler trials were conducted on one of these boilers to answer the question outlined above. In general, a high rating was selected for any given fuel and two trials of 9 hours each were conducted at that rating. The coal fed to the furnace was then reduced by 200 pounds per hour, and two more trials made; and so decreasing in the coal fed from day to day, the law of variation for the boiler and for the fuel is revealed, and a curve of dollars per 1,000 pounds of steam may be drawn. In this way experiments were tried upon five different mixtures and it was found that as the proportion of the hard coal increases, the lower the fuel cost per unit of steam becomes.

The fuel cost for generating 1,000 pounds changes as the load changes with any given mixture: it is therefore, not possible to draw correct conclusions by averaging the results for a series of trials. For if in one case there is a comparatively large number of tests at low rating, that case will show a relatively greater advantage in regard to fuel cost. In computing the costs the average of all ordinates of a curve is taken as the fuel cost for the particular mixture in question, and the following table gives comparative figures when the various fuels are used, the price of birds-eye anthracite coal being $1.85 and of bituminous coal $3.05.

Fuel Mixture.	Fuel cost 1000 lb. equivalent steam	Relative costs
All soft coal	$0.1205	1.00
1 part hard and 2 parts soft coal	0.1120	.93
1 part hard and 1 part soft coal	0.1085	.90
2 parts hard and 1 part soft coal	0.0985	.809
3 parts hard and 1 part soft coal	0.0940	.781

The curves have been plotted on Figure 4. Figure 5 shows the general results of the trials themselves, arranged for convenient and rapid comparison. It may be noted that the figures and curves both show that it is possible to develop more horse power—that is, to carry greater load—by decreasing the hard-coal proportion, even excluding

	Number of Test	Boiler Horse Power	Fuel Cost Per 1000 Lb. Equivalent Evaporation	Evaporation: Combined Efficiency	Evaporation: Actual Dry Coal	Evaporation: Equivalent Dry Coal	Evaporation: Equivalent Combustion	Coal Per Sq. Ft. Grate Surface Per Hour	
4.370	B 24....	1106	$.1321	68.3	8.85	10.30	11.87	53.2	All Soft Coal.
4.372	B 24....	1068	.1312	68.6	9.34	10.36	11.80	51.	
4.373	B 24....	925	.1178	76.6	10.51	11.57	12.91	39.6	
4.374	B 24....	914	.1171	75.5	10.23	11.38	12.66	40.	
4.385	B 24....	651	.1172	76.9	10.32	11.6	12.68	27.8	
4.386	B 24....	694	.1227	73.5	9.85	11.08	12.2	30.9	
4.387	B 24....	761	.1202	75.1	10.09	11.32	12.36	33.	
4.388	B 24....	834	.1204	74.7	9.865	11.28	12.29	36.6	
4.389	B 24....	887	.1198	75.2	10.03	11.34	12.43	35.2	
4.390	B 24....	918	.1262	71.4	9.78	10.77	12.01	42.2	
4.391	B 24....	1039	.1257	71.8	9.71	10.82	12.23	47.5	
4.392	B 24....	1027	.1248	72.4	9.67	10.9	12.52	46.6	
4.393	B 24....	1044	.1227	73.5	9.92	11.09	12.6	46.5	
4.3112	B 24....	1171	.1170	77.4	9.78	11.66	13.47	49.8	
4.3113	B 24....	1046	.1242	72.5	9.195	10.93	12.67	47.2	
4.368	B 24....	985	.1302	65.	8.24	9.08	12.49	53.8	1 of Hard Coal. 2 of Soft Coal.
4.369	B 24....	947	.1238	68.5	8.16	9.57	12.09	49.	
4.375	B 24....	900	.1091	77.6	9.795	10.84	12.20	41.	
4.376	B 24....	914	.1080	78.	9.71	10.90	12.36	41.5	
4.366	B 24....	962	.1251	65.2	7.92	8.734	11.29	54.5	1 of Hard Coal. 1 of Soft Coal.
4.367	B 24....	848	.1286	63.4	7.65	8.50	10.85	49.4	
4.377	B 24....	825	.1061	76.8	9.09	10.30	11.81	39.8	
4.378	B 24....	796	.1091	74.6	8.90	10.02	11.8	39.4	
4.379	B 24....	817	.1073	76.	9.16	10.19	11.78	39.6	
4.380	B 24....	786	.1076	75.8	9.06	10.16	11.75	38.4	
4.381	B 24....	788	.1041	78.5	9.41	10.51	12.03	36.4	
4.382	B 24....	738	.1027	79.5	9.61	10.65	11.82	34.3	
4.383	B 24....	733	.1037	78.7	9.44	10.54	11.82	34.2	
4.384	B 24....	573.5	.1032	79.	9.35	10.85	11.91	27.2	
4.394	B 24....	1003	.1052	74.1	8.61	9.54	11.68	52.	2 of Hard Coal. 1 of Soft Coal.
4.395	B 24....	956	.1074	72.6	8.49	9.34	11.54	50.6	
4.396	B 24....	861	.1009	77.5	8.32	9.96	11.93	42.5	
4.397	B 24....	836	.0972	80.1	8.62	10.33	12.30	40.	
4.398	B 24....	809	.0915	85.4	9.2	10.99	12.78	36.4	
4.399	B 24....	706	.0935	83.1	9.	10.73	12.49	32.4	
4.3100	B 24....	913	.1103	70.8	7.64	9.1	11.37	49.5	
4.3101	B 24....	882	.1183	66.	7.11	8.48	11.2	51.4	
4.3102	B 24....	956	.1025	76.1	8.2	9.8	12.59	48.2	
4.3103	B 24....	961	.1014	77.	8.34	9.9	12.72	48.	
4.3104	B 24....	894	.1072	72.8	7.91	9.36	12.49	47.2	
4.3105	B 24....	762	.0935	83.2	9.09	10.74	12.98	35.4	
4.3110	B 24....	637	.0841	89.8	9.54	11.3	13.01	27.84	3 of Hard Coal. 1 of Soft Coal.
4.3111	B 24....	604	.0892	84.6	8.945	10.65	12.18	28.1	
4.3108	B 24....	806	.0998	75.6	8.06	9.52	12.27	41.8	
4.3109	B 24....	724	.092	82.	8.72	10.32	12.85	34.6	

FIG. 5. RESULTS OF TRIALS IN THE BURNING OF MIXED FUELS.

it altogether for loads exceeding 1,000 horse power. For loads up to 1,000 horse power, or 167 per cent. of rating, a mixture consisting of 2/3 cheap hard coal will give lower fuel costs than will the clear soft coal; and the fuel cost for all soft coal advances rapidly after passing the load of 1,000 horse power. In any event, the best way to carry a load is to select the coal mixture suited for the load at hand and to change proportions of fuel when the load changes. As a rule 167 per cent, or in other words 67 per cent overload, is ample for boiler work and this load can be carried with 2/3 cheap coal. Should the demand for steam increase, the fuel proportions can be changed. Probably a 3-to-1 mixture will answer for night loads in many cases.

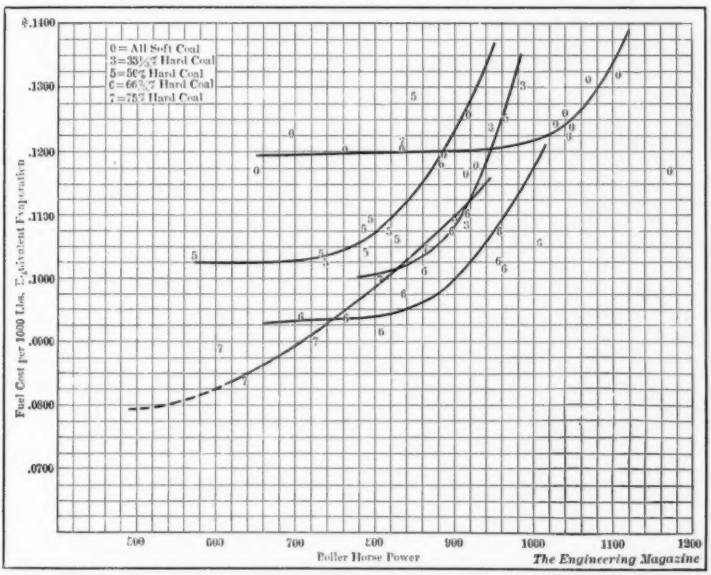


FIG. 4. CURVES OF COST PER 1,000 LB. OF STEAM WITH VARIOUS FUEL MIXTURES.

Gas analyses were made on samples taken at the bottom of the second pass, that is, two-thirds of the way through the boiler, during some of the trials, and on the average 13 per cent was the proportion of carbon dioxide gas.

The computations for costs of fuel have been based upon prices current in June, 1909, per long ton delivered in Schenectady, $1.85 for low-grade anthracite and $3.05 for bituminous coal. It is possible that some improvement might be made in the quality of the hard coal

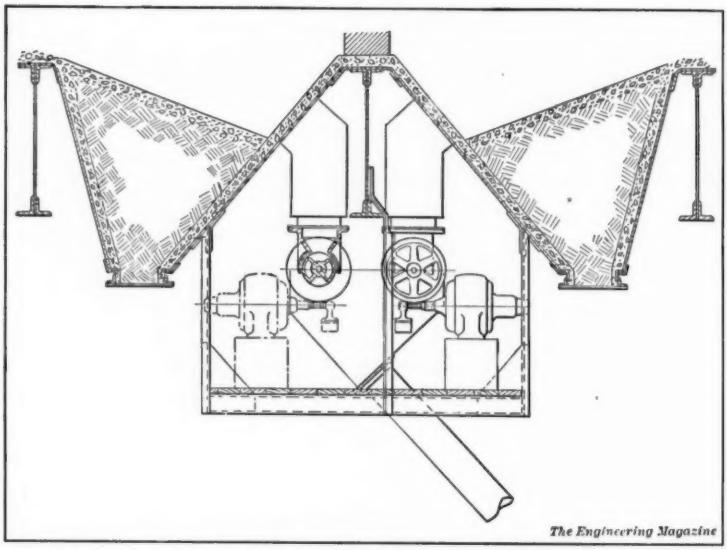


FIG. 6. MECHANICAL DEVICE FOR FEEDING MIXED FUEL IN VARYING PROPORTIONS.

furnished for it is subject to the same variations in quality that affect the value of soft coal.

The following fuel analyses may be considered representative for the 47 trials.

	Hard coal, per cent	Soft coal, per cent
Moisture	2.38	.44
Volatile matter (dry coal)	11.99	26.63
Fixed carbon " "	69.40	66.83
Ash " "	18.61	6.54
B. T. U.	11353	14569

It will be noted that some of the points do not fall on the curves as drawn and there is an occasional variation of considerable magnitude. This is true of one point in particular on the soft-coal curve marked zero. These variations may come from errors in reading instruments. There are enough points falling close to each curve to determine its character. It is further to be added that not enough trials were conducted with a mixture of 3/4 hard coal to determine definitely the lower end of the curve. It may be stated, however, that the behavior of the boiler and furnace on loads below 600 horse power was of little value in its bearing upon the question of practical boiler

economy. The shape of this curve above 600 horse power is definite as shown.

The drawing, Figure 6, shows a mechanical feeding device now in use for feeding two kinds of coal in varying proportions to one of the stoker hoppers described in this paper. It is to be noted that the figure shows two hoppers reaching below the coal-handling machine. These hoppers were intended for use when one kind of coal only was burned. When the partition shown on the drawing was erected these two lower hoppers were filled with ashes and concrete and an auxiliary opening forming a smaller hopper was arranged as shown in the figure.

It will be noted that the live element in the feeder is a roller with openings for two segmental portions of its circumference. As this roller rotates a small amount of coal is allowed to pass into the pipe below leading to the stoker. Each kind of coal has a roller of this sort and each roller is driven by a motor. The motor on one side, say the left hand, is started by a movement of the stoker shaft, which rotates about once in one minute. This motor continues to feed coal until it is stopped by the stoker shaft having taken one-half a revolution. The act of stopping the first motor starts the second, which feeds a second sort of coal, and this feeding continues until it is shut down by the completion of a cycle of the stoker shaft. The change in the proportions of the coal fed is made by varying the speeds of the two motors, and it is possible to run either motor at such a speed that it will supply a boiler with its own kind of coal while the second roller stands still. This makes it possible to burn either kind of coal alone. The mixing may take place either in the hopper, in the pipe, or in the lower hopper.

It is particularly to be noted that by the use of two bins with a definite kind of coal in each, it is possible to control the fuel mixture with precison. It has at times been proposed to spread the contents of a car of soft coal, for example, over the surface of a large bin simply by moving the dump block of the conveyor, following this with the contents of a car of hard coal which is distributed in the same way. If the bin was filled in layers to the top in this way the resultant mixture would probably be complete, or at least complete enough for furnace purposes. This method, however, gives one mixture only, and there is no possibility of changing that mixture. There is no chance to use good coal for heavy peak loads with the accompanying increase of cheap coal as the load decreases.

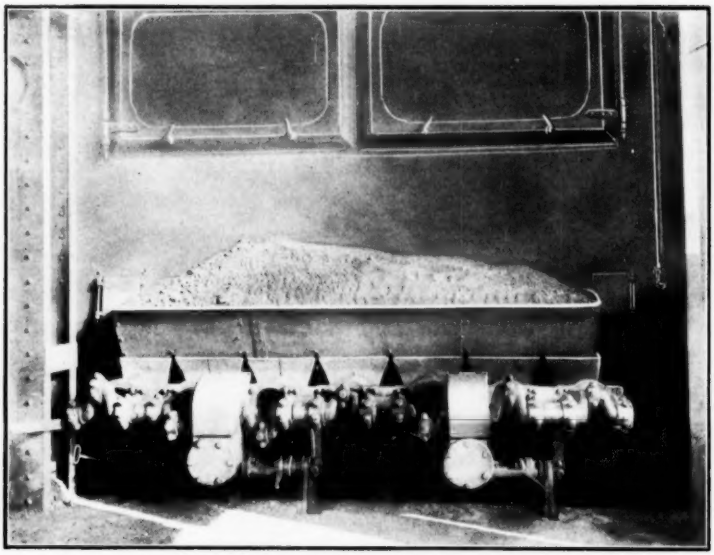


FIG. 7. MECHANICAL STOKER HANDLING MIXED FUEL.

One very important objection to this sort of handling coal in the bin lies in the irregularity of coal supply. It usually happens that the two sorts of coal are furnished by different coal companies, and there is liable to be temporary delay in the supply of either sort. It is extremely difficult to have the two kinds supplied uniformly.

THE CONCENTRATION OF MAGNETIC IRON ORES.

By N. V. Hansell.

In his opening sentences Mr. Hansell indicates the economic importance of his subject with such clearness that no further emphasis on that point is needed. He discusses it with authority, and with a breadth of scope and clearness of exposition that make his article important as a review of the state of the art and a work of reference for students and investigators.—THE EDITORS.

THE mineral resources of America and of the world are obviously limited. This is just as true of iron ore, the most abundant and relatively the cheapest, as it is of those carrying the precious metals. With the rapidly increasing consumption of iron and steel, the available supply of iron ore may therefore at some time in the future be exhausted. When this will occur is the subject of much theorizing. Widely different conclusions have been drawn by those who have made a study of the question. This is to be expected, as the calculations are more or less based on assumptions. Still, they all clearly indicate that in a relatively short time ores sufficiently rich in iron and free from deleterious elements to be melted in blast furnaces without any previous preparation will be used up.

There is, however, no danger of any famine in the supply of raw material for the iron and steel industry until a future so distant that there is no way of even guessing it. There are enormous quantities of low-grade and impure iron ores that have been lying, so to speak, in reserve, and so far have only been touched. Among them are those with a high percentage of elements such as sulphur, phosphorus, titanium, etc., which are detrimental in iron manufacture, besides the numerous and great occurrences of lean ores that carry high percentages of gangue minerals or moisture. These are just beginning to play an increasingly important *rôle,* although the preparation through which they have to pass before they can be profitably smelted considerably increases the cost per unit of iron above the mere mining cost.

An efficient and cheap method of preparing them, by means of concentration or otherwise, is therefore a subject of the utmost interest to everybody connected with the iron and steel trade. A number of important developments in this line have recently been mentioned or discussed in technical papers; for instance, the separation

of the Adirondack titaniferous ores so as to make them useful in present blast-furnace practice; the preparation of Cuban low-grade ores, which on account of their extremely high water content once were considered of little value; and the economical conversion of low-grade ores in general, both hematites and magnetites, into a product fully equal, if not superior, to the best natural iron ores obtainable.

In the following lines, that part of the problem of improving low-grade iron ores which has so far created the most interest—the magnetic concentration of low-grade magnetites—will be chiefly discussed. By the term "concentration" we mean in this connection the enrichment of the valuable constituent of a low-grade ore, in this case magnetite, by its separation from the gangue minerals, and incidentally the lowering of the percentage of deleterious elements.

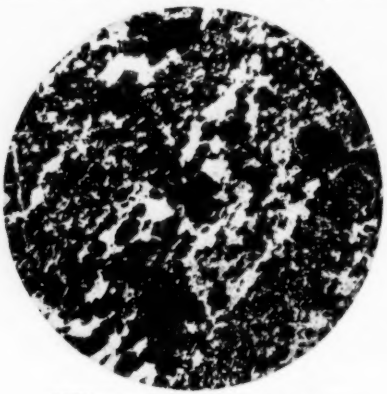


FIG. 1. SECTION OF IRON ORE.

Preceding the magnetic separation, the minerals must be freed from one another by a preliminary crushing and grinding of the crude ore. In every separating process, the governing rule of crushing is to carry the comminution to the point where there is the minimum number of middling grains, i. e., grains composed partly of gangue and partly of metal-bearing minerals. This is generally a very important part of the treatment, and must be looked into carefully, as while the separation proper often costs only a few cents per ton, the crushing of the ore may cost 20 or 25 cents or even more.

In the process as a whole, the crushing and the separation are intimately co-related. For one kind of ore, one method of crushing, combined with a certain type of separation, will give the best economical results; for another kind of ore, another crushing method and another separator will prove more advantageous. No single method of treatment can be said to be best in every case, but each ore has to be studied by itself, and the method most suitable for it must be found. There are ores that when broken to say 1½ inches or 1 inch can profitably be passed over magnetic separators and pure ore pieces and clean rock pieces be eliminated from the whole mass

before further crushing. There are even cases where a preliminary cobbing by hand can pay for itself. On the other hand, there are close-grained ores with a uniform intermixing of the magnetite all through the matrix, with which crushing at once to the fineness at which the minute magnetite grains will be freed from the rock minerals is the proper course to follow. The degree of fineness required has to be determined by crushing and separating tests. Sometimes, it is of advantage to precede or accompany these by microscopic studies of thin sections of the ore, with measurements of the average size of the magnetite crystals.

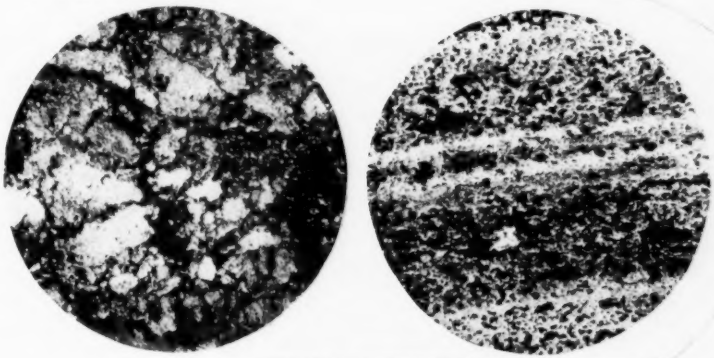


FIG. 2, 3. SECTIONS OF MAGNETIC IRON ORES.

The accompanying illustrations* show photographs of three such thin sections enlarged four times. In these, the opaque or black parts are the magnetite, the more or less grayish, various iron silicates, and the white, chiefly quartz. Illustration No. 1 shows magnetite in rather large crystals or irregular masses, often including quartz or other minerals. A clean crushing, i. e., one that will free the minerals from each other, will not be difficult to accomplish. In No. 2, the magnetite seems to fill the interstices between the pyroxene crystals, therefore forming masses of very irregular shape. A fine crushing is required if tailings reasonably free from iron are desired. No. 3 illustrates a very finely granulated ore of magnetite, quartz, and some feldspar. The magnetite occurs in well defined crystals of sizes varying from 1 millimetre down to 0.01 millimetre. Fine grinding is necessary, but can be expected to give good results. Sometimes polished surfaces of an ore, the texture of which is sufficiently coarse to be revealed without the use of a microscope, will bring out the inter-

* Illustrations 1, 2, 3 and 4 are taken from *Jern-kontorets Annaler*, Vol. 58.

relation of the minerals and their structural characteristics. Figure 4 is a photograph in half scale of such a polished surface. The magnetite, by the reflected light, shows as the lighter constituent and the quartz and the silicates as the dark ones. It can be seen that a large part of the magnetite occurs in rounded pure masses, in sizes up to that of a nut, surrounded by silicates almost free from magnetite. By coarse crushing and cobbing, this magnetite can be extracted and some of the gangue can be eliminated as barren rock. The rest, perhaps less than one-half the original tonnage, will constitute midlings. It is a closely crystallized matrix, which needs further crushing before treatment over separators.

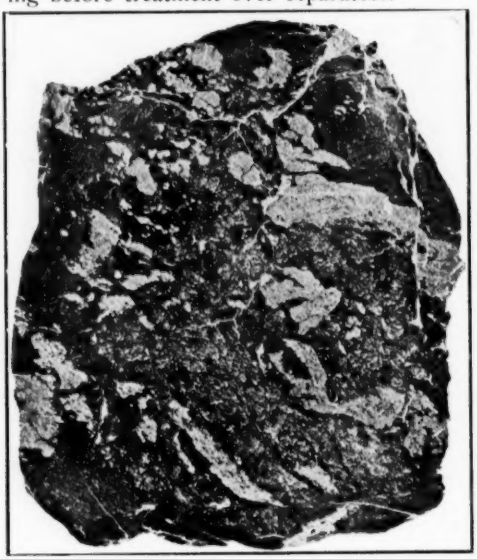


FIG. 4. POLISHED SURFACE OF IRON ORE.

It is thus evident that even when it has been determined that an ore is to be enriched by magnetic concentration, there is no royal road to the solution of the problem. A description of a few characteristic plants will give some idea of the radical differences in methods of treatment of magnetic iron ores in order to accomplish the desired results of economy and satisfactory quality of the finished product.

Principles of Magnetic Concentration.

All magnetic concentration is based upon the difference in physical character of different minerals or metals that is called permeability; that is, the ratio of their conductivity for the lines of force to that of air. When introduced into a magnetic field, substances with a higher conductivity than air—and most substances are of this nature—cause a concentration of the lines of force, which flow through them in preference to the surrounding atmosphere. This gives them

polarity, making them independent magnets that are exposed to the attraction of the poles causing the field. Minerals of higher permeability are attracted with greater force, and can on that account be separated from minerals of lower permeability.

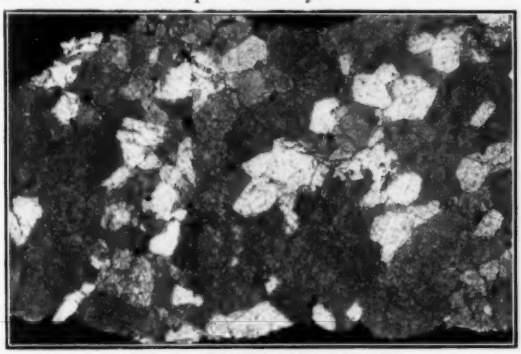


FIG. 5. TITANIFEROUS IRON ORE.

The determination of the actual degree of permeability of minerals meets with a number of difficulties, principally on account of variations in other physical properties as well as on account of chemical differences in specimens from different localities. Still, the results obtained by a number of diligent investigators give good assistance in the study of this problem. It is found that magnetite is easily separated from quartz, feldspar, apatite, pyrites, etc., but with greater difficulty from pyrrhotite and ilmenite. This has to be taken into consideration in the design of magnetic separators, especially when they are to be used for the treatment of minerals with only a slight difference in permeability. The separation of magnetite and ilmenite meets with special difficulty on account of the variation in the chemical composition of ilmenite. Generally a part of it can be eliminated, but the remainder is so highly magnetic that it stays with the magnetic concentrates. Figure 5 shows a polished and etched surface of magnetite from Lake Sanford, N. Y. The magnetite grains are dark on account of the solvent action of the etching, while the ilmenite retains its lustre from the polishing. It will be noticed that the two minerals are well separated from each other in the ore, with sharp boundaries. Mr. David H. Newland* gives some results from various concentrating experiments. The crude ore generally carries about 15 per cent TiO_2. By crushing to ¼ inch, a separation test at Mineville still showed 8 to 10 per cent TiO_2, corresponding to 5 to 6 per cent Ti. A laboratory test gave, after comminution to 40 mesh, 5.32 to 6.49 per cent TiO_2 in the magnetic concentrates, while the iron was

* *New York State Museum Bulletin* 110. Geology of the Adirondack Magnetic Iron Ores. By David H. Newland—from which also Fig. 5 is taken.

about 65 per cent. These results are quite satisfactory, and very gratifying inasmuch as they indicate the feasibility of a successful exploitation of the great deposits at Lake Sanford, N. Y., and elsewhere where the ore is of a similar nature.

When pyrrhotite is present in the crude ore, the sulphur is generally enriched in the magnetic concentrates, making a subsequent roasting necessary.

Magnetic Separation.

Magnetic separation of iron ores was employed as early as the middle of the last century, but it was first about thirty years ago that the process first began to replace successfully the then prevalent wet jigging of such ores. Since then, a number of types of machines have been designed and brought out in the market. It is said that not less than five hundred patents for magnetic separators have been granted in the United States alone. Among these there are a few that on account of simplicity in construction and large capacity have gained wide popularity and are used to the exclusion of the others.

There are some rules that govern the operation of every magnetic separator and have to be considered in their designing; such as the necessity of bringing the crude ore into the magnetic field in a thin uniform layer, and of some device to carry the attracted magnetic particles out of the field to discharge them separately from the non-magnetic ones. The feed must be so arranged that the magnetic particles are not hindered in their attraction toward the pole by intervening non-magnetic particles. Otherwise, on account of the strong pull they might carry with them some of the latter material, making a product that is not clean. In order to remove the attracted particles, there are a number of devices in use, for instance, secondarily induced poles that are caused to travel out of the field of the primary poles. They then lose their magnetism, permitting the particles to drop. Another way is to have a non-magnetic drum or belt toward which the particles are drawn and against which the magnetic force holds them until they are carried out of the field. Another method is the deflection of the magnetic particles from the ore while it falls in a thin stream in front of stationary magnets. In every case, the final discharge of the concentrate is effected by gravity or centrifugal force. Washing with water in the wet method, or air blast in the dry, are sometimes provided to assist in cleaning the magnetic concentrates from non-magnetic particles.

The efficiency of the separator is of course largely determined by the intensity of the magnetic field. This is governed by the number

of ampere turns, the length, and the material forming the magnetic circuit, its cross-section, the air-gap, and the shape of the pole pieces. For instances, by beveled pole pieces the lines of force are concentrated, intensifying the field and making the machine well adapted for the separation of minerals with low permeability. In all well designed separators, the intensity of the field can be varied to suit the conditions of the feed. It is controlled by the amperage and the distance between the poles.

As in the present paper we are dealing only with such magnetic separation as applies primarily to the enrichment of magnetite, we can to advantage group the various types of separators used in the following three classes, our classification being rather according to the way the machines are employed in the plant than to any difference in principle or any mechanical distinction.

1.—Cobbing Machines.
2.—Dry Separators.
3.—Wet Separators.

In describing a few machines of the various groups, those that have gained the greatest recognition as efficient separators and at present are most widely employed have been selected rather than others, however cleverly constructed these may be.

Cobbing Machines.

Cobbing machines are such separators as are used for the separation of coarse crushed ore of ½ inch or so and larger. The best known types are the Wenström, the Ball, and the Gröndal. They all treat either wet or dry material.

The Wenström Separator (Figure 6) was devised in Sweden, as early as 1883. It consists of a horizontal drum built of alternating bars of wood and soft iron. The latter have projections toward the inside, alternate bars having respectively two and three such. Inside the drum, there is an electromagnet with five pole pieces in positions corresponding to the projections of the bars, and so arranged that the bars have alternately north- and south-pole magnetism. The electromagnet, which is stationary, is placed nearer one side of the drum and the pole pieces extend to its vertical diameter. The ore is fed at the top of the drum and is carried forward when it revolves. The non-magnetic pieces drop at once, while magnetic ones are held against the soft-iron bars until they have passed the vertical diameter, where they lose their magnetism. The attracted pieces then drop into a separate receptacle. The machine is built in several sizes with various

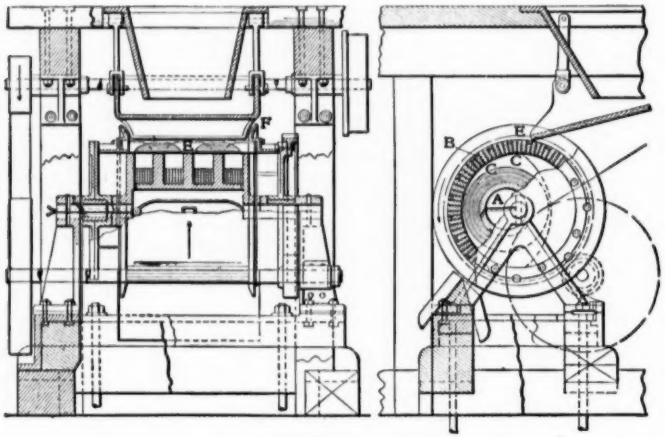


FIG. 6. WENSTRÖM COBBER.

capacities up to 5 to 7 tons an hour. It is still used in the United States at Cranberry, N. C.

THE BALL & NORTON COBBING MACHINE (Figure 7) consists of a drum of a non-magnetic material that revolves around a stationary system of 16 or 18 poles arranged radially with alternating polarity. The ore is fed on the top, and the magnetic pieces, while they are carried in front of the magnets, turn over repeatedly on account of the changes in polarity. Thus non-magnetic pieces are caused to drop off. The pieces that are attracted by the magnet are carried past the last pole and thrown off by centrifugal force. This type is used to some extent in the United States.

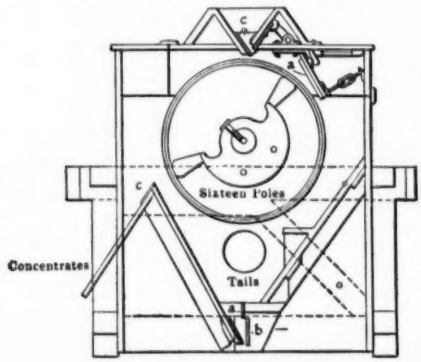


FIG. 7. BALL & NORTON COBBER.

THE GRÖNDAL COBBER (Figure 8) is merely a combination of a drum machine and a belt conveyor. The crude ore is carried by the belt until it comes under the influence of the magnetic field. The four poles shown in the illustration have alternating polarity. Tailings and concentrates drop into different hoppers.

Dry Separators.

In the dry separators it is generally very essential that the ore be perfectly dry, as even a small percentage of moisture impairs the results, particles of gangue minerals sticking to the magnetic particles and lowering the iron percentage of the concentrates. Mills fitted with this kind of separators are therefore generally furnished with dryers. Among the most efficient machines of this class are the Ball & Norton double drum and the Ball & Norton belt separator. They were both designed in the 80's, but on account of their simplicity and efficiency they have held their place and are used extensively.

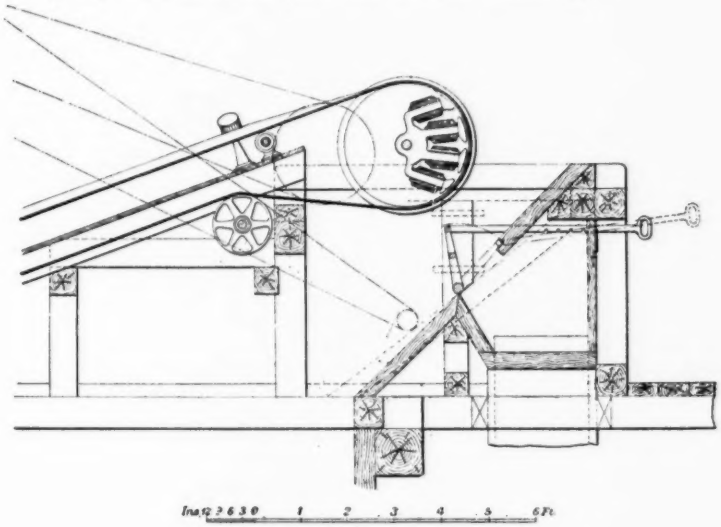


FIG. 8. GRÖNDAL COBBER.

The Ball & Norton Double-Drum Separator (Figure 9) consists of two parallel drums of non-magnetic material placed close to each other and revolving in the same direction. Inside each is a system of electromagnets with alternating polarity. In the first, the feeding drum, they underlie a little more than half the circumference. In the second, the finishing drum, they are somewhat fewer. The ore is fed on the top of the first. The tails fall into the hopper right under this, while the magnetic particles are carried ahead toward the finishing drum, to the magnets of which they are drawn the instant they pass out of the magnetic field of the feeding drum. The centrifugal force also assists in the transferring of the material from the first

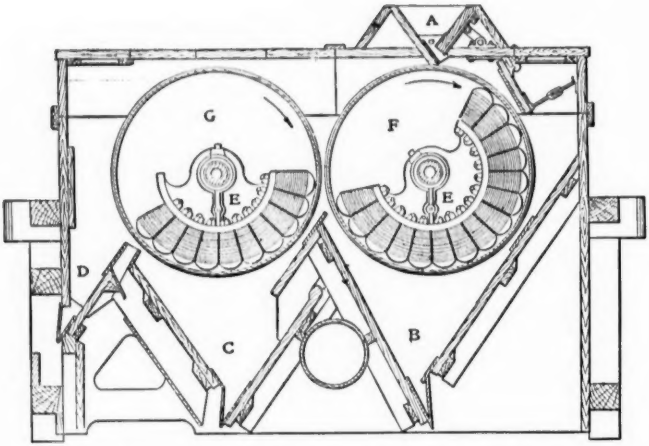


FIG. 9. BALL & NORTON DOUBLE-DRUM SEPARATOR.

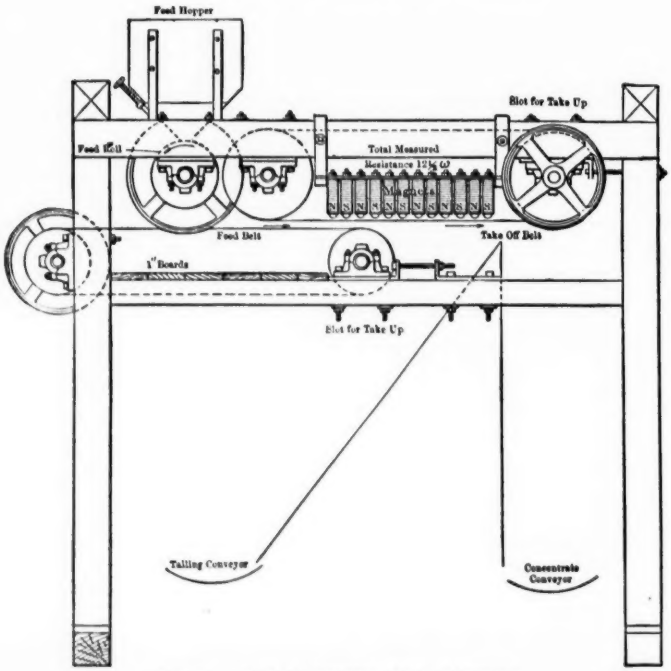


FIG. 10. BALL & NORTON BELT MACHINE.

drum to the second. This revolves more rapidly and has a magnetic field of lower intensity. Middlings, or particles with less permeability, are therefore thrown off and pure magnetite is retained and delivered to a separate chute where it passes out of the magnetic field. The daily capacity of the separator is from 12 to 20 tons of crude ore crushed so as to pass a ¼-inch or ⅛-inch mesh.

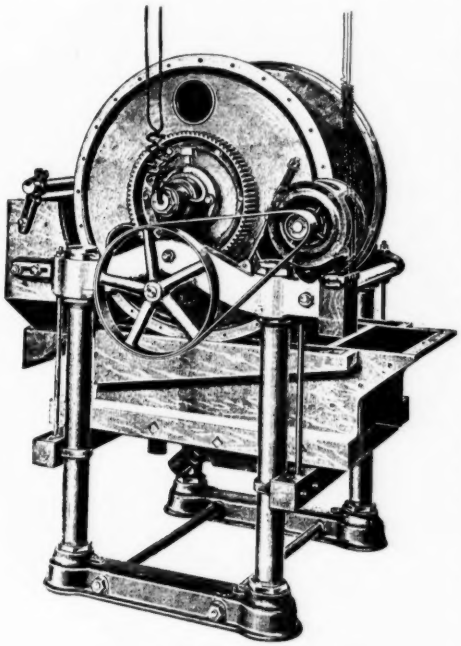


FIG. 11. GRÖNDAL "NO. 5" SEPARATOR.

BALL & NORTON BELT MACHINE (Figure 10).—The ore is fed on a horizontal belt, which carries it into a magnetic field created by a series of magnets of alternating polarity placed above the belt. The attracted particles are carried out of the field by a second belt running in the same direction between the ore stream and the poles.

Recently some new dry separators have been designed and tested with very good results. They have, however, not yet been tried in practice to any great extent.

WET SEPARATORS.

Among wet separators, the Gröndal No. 5 (Figure 11) takes a place of its own, being nearly without a competitor in its field. It is the product of the evolution of a series of magnetic separators devised during the last ten or twelve years by the well known Swedish inventor, Gustaf Gröndal. It consists of a brass drum containing a system of four or more electromagnets of alternating polarity, and rotating with its lowest point ½ inch above the water level of a weir box. The characteristic of the separator is that the pulp is not fed directly onto the drum but is brought into the field of magnetic influ-

ence in a weir box under it. The magnetic particles are drawn out of the water and against the drum. Carried by its rotation out of the field, they are easily washed off by water. The machines are generally operated in tandem, with a stronger field in the first, which gives clean tailings, and a somewhat weaker one in the second, so as to raise the iron content of the final concentrates. The separating capacity of each drum is 100 tons of crude ore per day.

Dry or Wet Separation.

A comparison between the two classes of finishing separators will result in a comparison between the two systems of separation that they represent, i. e., the dry and the wet. Each has certain points of advantage over the other, and it may be said that each has its own field. For a coarsely crystalline ore, especially one of the Hibernia or the Mineville type, the dry method is preferable. Fine crushing is not required in order to separate the constituent minerals. Therefore, little dust is produced, and the concentrates can be employed directly in the blast furnace without any inconvenience. An ore of the Chateaugay type, which must be crushed so fine that it all passes through ¼-inch holes before a thorough separation is possible, is about the size for which a wet separation proves more economical.

When an ore is fine-grained, the gangue minerals disseminated through the whole mass (See Figure 3) so that there is no possibility of liberating the grains of magnetite except by fine grinding, then the wet separation is indispensable. It is then the only solution of the concentration problem, as the amount of dust produced in dry fine crushing would make a good separation both difficult and disagreeable. It is almost impossible to prevent fine magnetic dust from adhering to the magnetic concentrates. The atmosphere of the mills would be filled with dust, which can not be kept out of bearings, etc., and makes the work in the mill unpleasant. The wet mill, on the contrary, on account of freedom from dust, can easily be kept clean.

The launders for the transport of the material between the different machines can be constructed at a slight incline, as the water current helps the material along. In the dry mills, the chutes have to have an angle of 40 to 45 degrees from the horizon. Rapid wear is the immediate result of this steep pitch. The sharp angle in the transportation through the mill necessitates additional elevators not needed in a wet mill with other conditions similar.

In artificial drying, it may also happen that if the temperature gets too high (and sometimes this is hard to prevent) a part of the

iron pyrites will be partly reduced, being converted into a magnetic sulphide, thereby increasing the sulphur content in the concentrates.

A serious objection to the wet method is the difficulty in cold climates of keeping water conduits and wet products from freezing in winter. Well constructed buildings, however, and artificial heating during the coldest period to keep the mill temperature above the freezing point, prevent this. It is only in storage bins inside or outside the mill, where the ore is at rest, that special precautions must be taken. Steam coils under the bin bottom are used at some places. It is of course not always practicable to load the wet concentrates into open railroad cars when it is too cold. They might freeze solid before reaching their destination. As in most wet mills they are briquetted or nodulized before being shipped, the difficulty is thus overcome. Otherwise, it is best to permit them to freeze and load them in chunks into open cars.

The amount of water needed for the wet process is as a rule very small, and the cases where it is not available in sufficient quantity are exceptional. Moreover, as it is generally necessary to have a settling pond for the outgoing slime water to prevent the floating slime from spoiling waters below the plant, it is obvious that the same water can circulate and be re-used indefinitely, so only what is lost by evaporation or unavoidable leakage has to be replaced.

As a whole, the wet mill, especially when the Gröndal system is used, excels on account of the extreme simplicity of the layout. From the preliminary crushers, the ore passes directly to ball mills, from which it continues to the separators. Rolls, screens, etc., are absent. When a very high grade of concentrates is required, the heads from the separators are reground in tube mills and reseparated. It seems at first as if grinding iron ore in tube mills would be entirely too expensive an operation for such a cheap commodity. Still, practical results at a number of plants demonstrate that the cost per ton is small in comparison with the increased value of the finished product on account of its purity; 68 to 70 per cent iron in the concentrates at such plants is no uncommon thing.

The Concentrates.

In the dry methods, the ore is generally comminuted in stages with a number of crushers and rolls with intermediate screens. The aim is to grind the ore no finer than is absolutely necessary, so that the product shall be as coarse as possible. Still, it often contains a large percentage of fines or dust, which have a tendency to blow over in the

flues of a blast furnace, and might cause a number of irregularities in its operation. The concentrates from the Chateaugay ore, for instance, contain generally more than 50 per cent that will pass through 40 mesh screens and about 15 per cent finer than 100 mesh. To overcome the difficulties connected with their use, the method at present at this place and elsewhere is to pass them over a screen and nodulize the fines, which is done in a long rotary kiln similar to those used in cement manufacture. It is usually fired from its discharge end with pulverized coal blown in from that end. The kiln capacity is 100 to 150 tons daily.

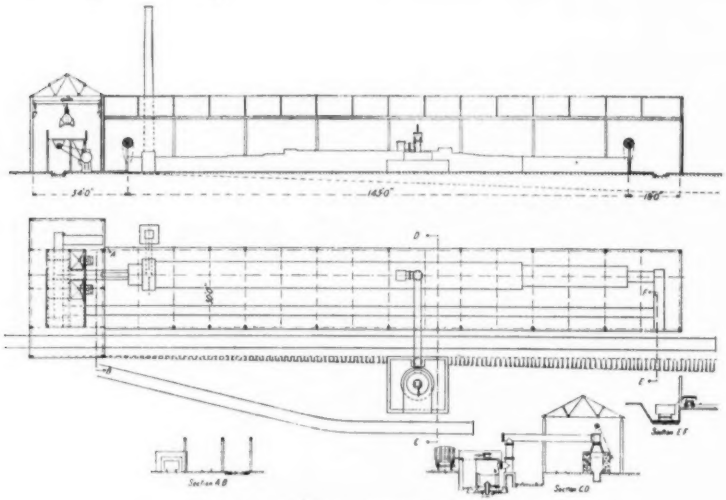


FIG. 12. GRÖNDAL BRIQUETTING KILN.

The concentrates from the wet method are usually briquetted in the Gröndal briquetting kiln (Figure 12). This is a long channel furnace through which the fine ore, pressed into bricks and loaded on flat cars, slowly passes. The cars together form a continuous, intermittently moving platform, dividing the kiln into two compartments. Through the lower one cold air is drawn in order to protect the trucks from the heat of the upper one. The kiln is fired with gas, which enters from the roof near the discharge end. Here is the greatest heat, reaching 2,500 degrees F. The combustion gases travel toward the inlet end of the kiln, meeting the damp briquettes, drying them, and slowly heating them to the intense temperature of the combustion zone. No binder is used, the moisture of the briquettes being suffi-

cient to hold them together until they agglutinate. Besides the advantage of having the finely granulated ore converted into regular-shaped briquettes, firm but porous, the process eliminates the sulphur, as the briquetting kiln is the most efficient calciner and desulphurizer that has yet been devised. The capacity of such a kiln is 100 tons of briquettes daily.

In comparing results obtained at different separating plants, it is not enough to give the iron content of the crude ore, the concentrates, and the tailings—the iron of which last is lost. From these three values, the recovery of iron can be calculated in percentage of the iron in the original ore. This is of course an interesting figure, as indicating the efficiency of the operations, but there are many other factors that influence the results. In the first place, we have before pointed out that the most economical method of treatment is not the same for different ores. Sometimes, when, on account of freedom from phosphorous and sulphur, the concentrates produced command in the market an extraordinarily high price per unit of iron, it may be profitable to re-crush and re-treat the tailings once or twice, lowering their iron percentage to only 3 to 4 per cent. With another ore, it is better to waste 10 to 12 per cent or even more iron in the tailings, as the cost of re-handling them, with wear and tear on machinery, etc., would be higher than the revenue for the additional tons of concentrates that might be obtained. In talking about the iron content of the crude ore and its products, we usually mean only the iron combined in the mineral form of magnetite (or hematite). The iron in the silicates will stay in the tailings and is of course a complete loss. Sometimes considerable quantities, especially of ores high in dark minerals, are thus unavoidably wasted. The percentage of iron in these minerals varies greatly in specimens from different localities, as investigations by Prof. W. Petersson* indicate. In amphibole, for instance, from 2.11 per cent to 16.50 per cent, with an average in samples of nine sources of 8.76 per cent, in pyroxene from 3.05 per cent to 12.00 per cent, with an average in six samples of 9.2 per cent; in garnet from 17.45 per cent to 21.50 per cent, and so on.

We do not wish to give here any detailed description of the equipment and operation of various separating plants. In the valuable work of Prof. Robert Richards, on Ore Dressing, which for many years will be a standard reference book on these matters, such descriptions will be found. We will give the flow sheets of a few typical mills, which will show the travel of the ore from machine to

* *Jern-kontorets Annaler*, Vol. 54.

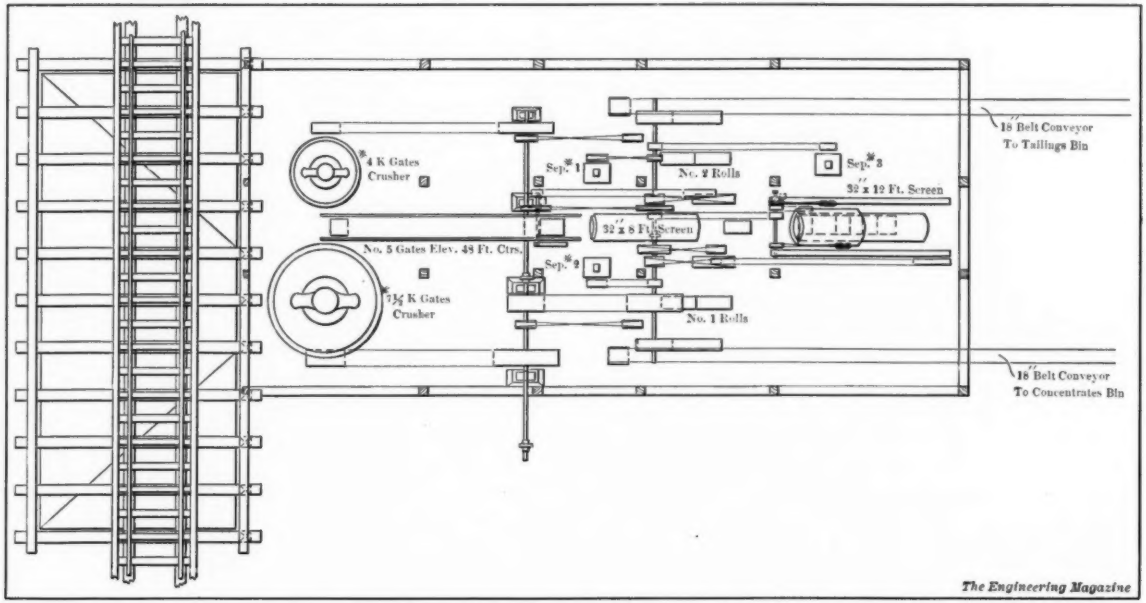


FIG. 13. PLAN, MOUNT HOPE COBBING PLANT.

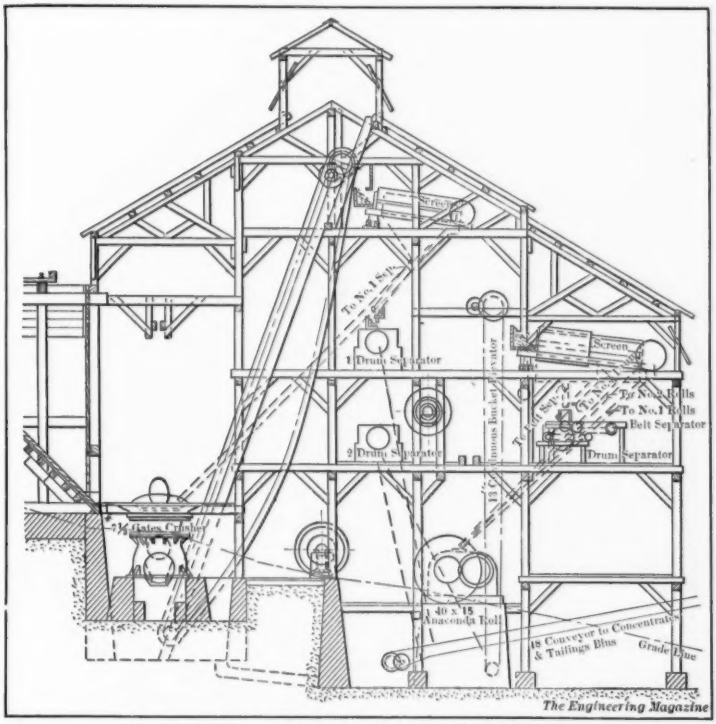


FIG. 14. SECTIONAL ELEVATION OF MOUNT HOPE COBBING PLANT.

machine and serve as illustrations of what has been said about the differences in the various systems of magnetic concentration of iron ore.

Mount Hope Cobbing Plant.

This plant has been in operation for about a year. It was erected in the first place to standardize an ore that as mine-run varied considerably in iron and sulphur. Now a cobbed product is obtained with always practically the same chemical composition, facilitating its use in the blast furnace. The plant (Figures 13 and 14), which was designed and erected by the Allis-Chalmers Co., has a daily capacity of about 600 tons. The cobbers are of the Ball & Norton type. The fine screenings are treated on Ball & Norton belt separators. It will be noticed from the flow sheet that from the first cobber, which is operated with low amperage, concentrates are obtained, while from

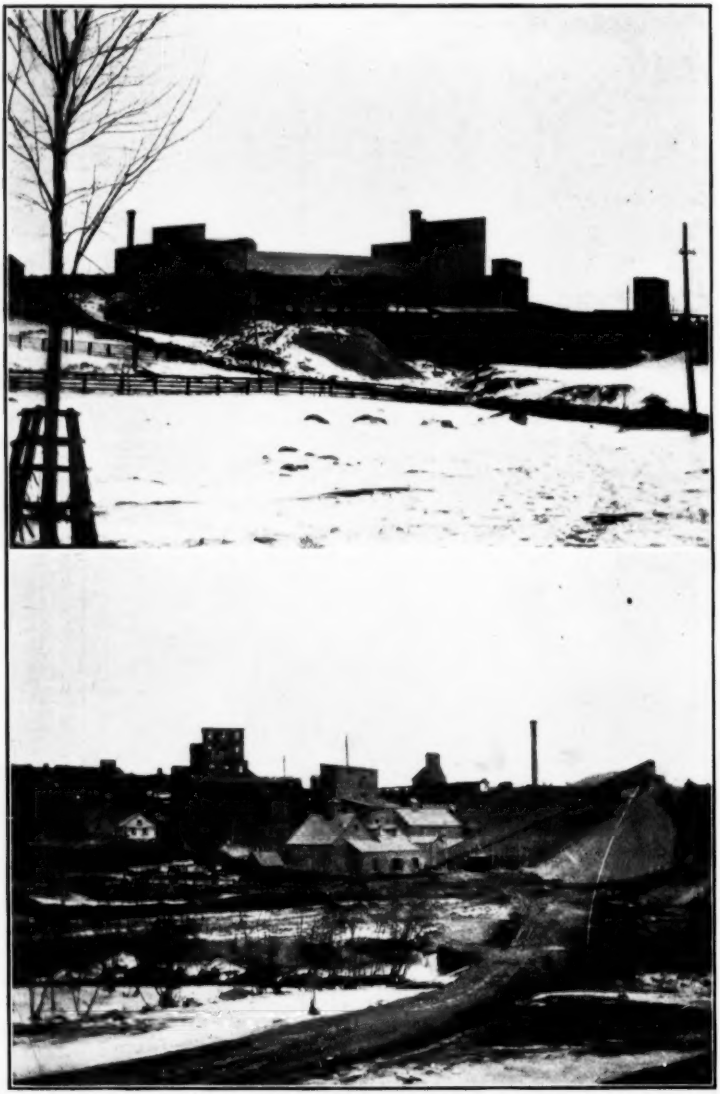
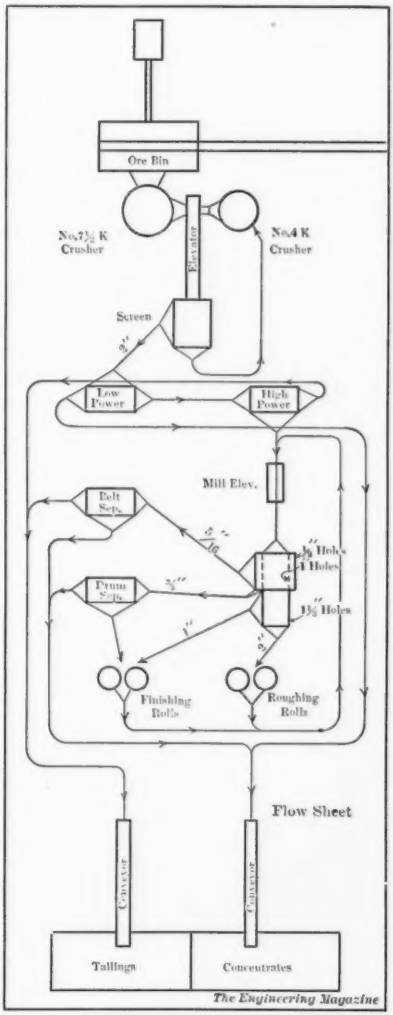


FIG. 15. TWO VIEWS OF THE MINEVILLE PLANT.

the second, which has a stronger magnetic field, pure rock pieces are discarded. The rest, being a middling product, is reduced in size and retreated.

Mineville Separating Plant.

At Mineville, Witherbee, Sherman & Co. are operating two mills (Figure 15), each with a capacity of treating about 800 tons of crude ore in 10 hours. These are typical dry mills, as can be seen from the flow sheet of Mill No. 2 (page 535). The ore treated in this is what is called the "Old Bed" ore, which in its crude state already holds upwards of 60 per cent iron, and its concentration is therefore rather a purification from phosphorus, of which element it contains from 1.50 per cent to 1.75 per cent. The tailings are treated over Wetherill separators, which are built to handle feebly magnetic ores. Here, in the first place, any magnetite that might have escaped in the previous operations is picked out. Afterwards, all silicates of iron, together with part of the apatite (which is the mineral form in which phosphorus usually occurs), are removed. Most of the apatite is non-magnetic, and is delivered with quartz, etc., as a final tailing product, which under the trade name of "first-grade apatite"



FLOW SHEET, MOUNT HOPE.

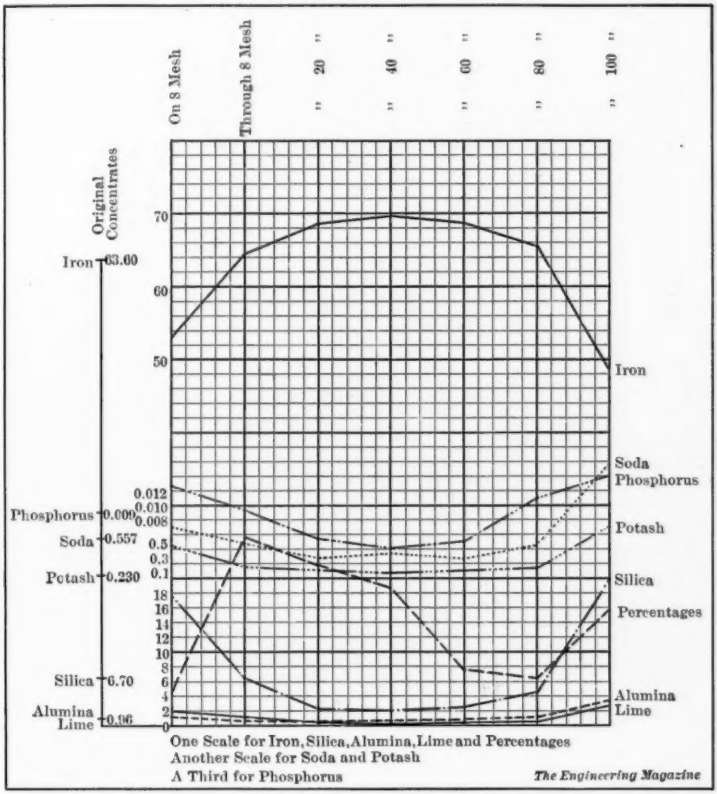
has a high market value. The part of the tailings that has been removed on account of its slight magnetism, is sold as second-grade apatite. The table below gives some average analyses. The flow sheet is given on page 535.

Material.	Daily Tonnage.	Iron Percent.	Phosphorus Percent.
Crude ore, old bed	800	59.59	1.74
Old bed concentrate	680	67.34	0.675
First grade apatite	60	3.55	12.71
Second grade apatite	60	12.14	8.06

FIG. 16. LYON MOUNTAIN.

Lyon Mountain.

At Lyon Mountain, N. Y., is treated the ore before referred to as Chateaugay ore. The treatment is somewhat similar to that of the Mineville ore, but on account of the higher value of the concentrates the re-treatment of middlings and tailings is carried a little farther. In the year 1905, a new mill (Figure 16) with a capacity of 800 tons per 10 hours was erected. It burned down after a year's operation. At present, the old mill, which was erected some 30 years ago and has since been changed and added to many times, has been put back in operation. The principle of the treatment is to crush all the ore to ¼ inch before delivering it to the separators. Middlings and tailings are re-crushed and re-screened.



SCREEN TEST, LYON MOUNTAIN.

	For 1 Ton of Concentrates.	Iron Percent.	Phosphorus Percent.
Crude ore	2.6	32.0	0.022
Concentrates	1	64.0	0.009
Tailings	1.6	9.0	0.034

A screen test of the concentrates with full analyses of all the screenings made by Mr. James Brakes is not without interest. It very clearly demonstrates the weakness of the dry process. By the elimination of the coarse material, which stays on the 8-mesh sieve, and the very fine, which passes through 100-mesh, and of which there is no less than 15.6 per cent, the iron content of the concen-

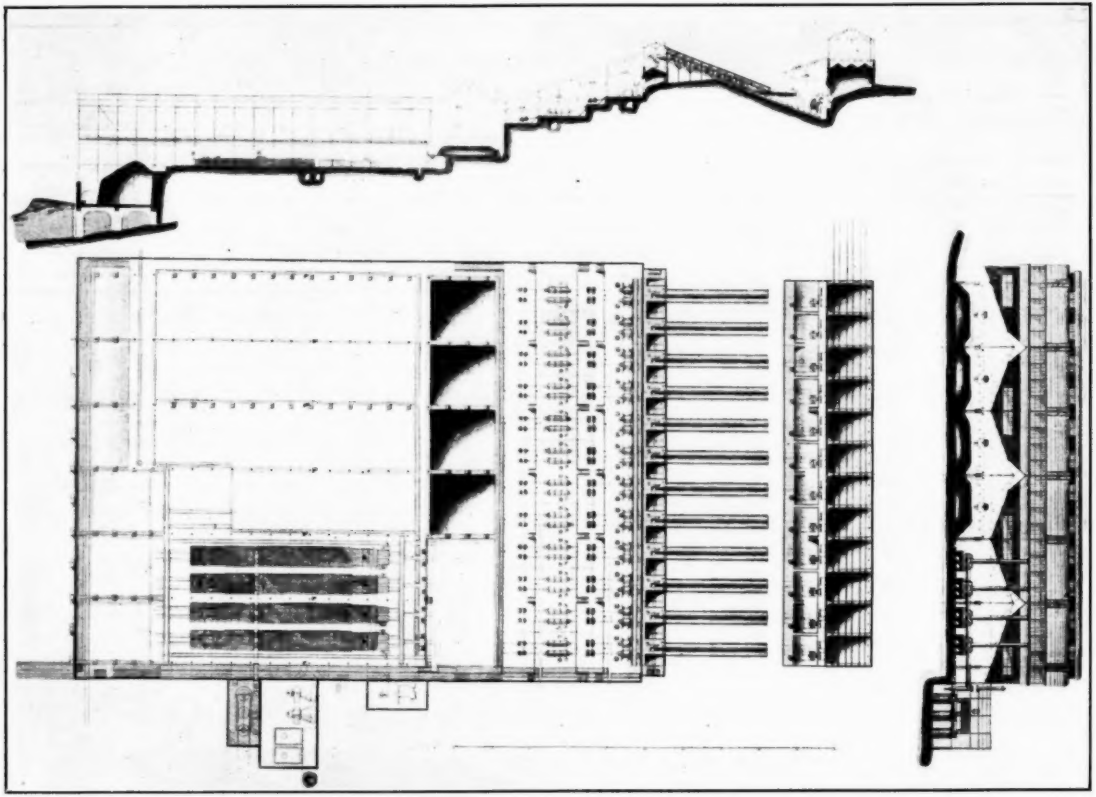
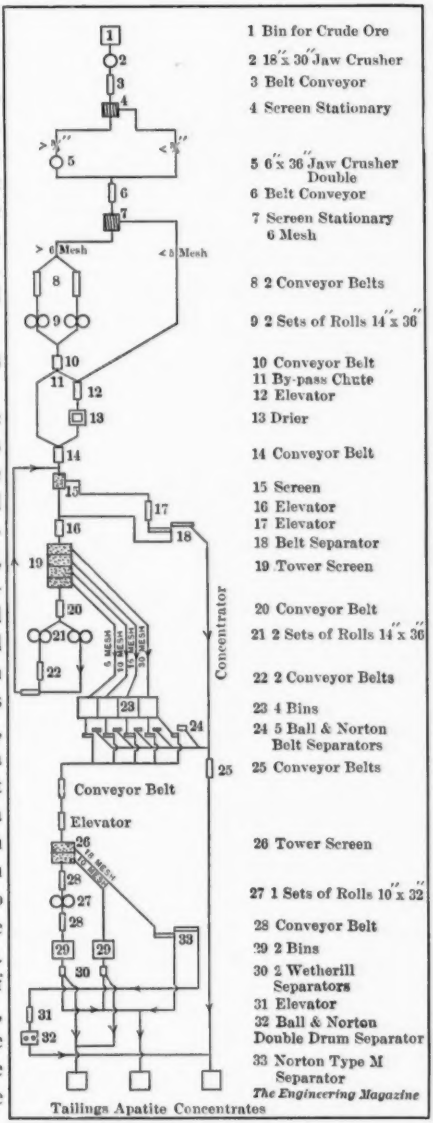


FIG. 17. SYD VARANGER (NORWAY) CONCENTRATING AND BRIQUETTING PLANT.

trates would be over 67 per cent and the phosphorus below 0.008 per cent. It shows that the ore ought to be ground so as to pass ⅛-inch mesh, and it also shows that non-magnetic dust adheres to the fine concentrates, lowering the value of the whole product. The screen test is charted on page 533.

Lebanon Concentrating Plant.

At Lebanon, Pa., the Pennsylvania Steel Co. is concentrating low-grade iron ores from Cornwall Ore Banks. Dry concentration was originally used, and different kinds of magnetic separators were tried with varying success, until finally the Gröndal system of wet concentration was installed. Now the ore, after coarse breaking in a gyratory crusher and a set of rolls, is delivered in a size of 1 inch to 1½ inch to Gröndal ball mills, from which it passes directly to Gröndal separators. The concentrates are nodulized. Comparative analyses of crude ore, concentrates, nodules, and tailings give the figures presented in the table at the top of page 536.



FLOW SHEET, MILL NO. 2, MINEVILLE.

ANALYSIS OF THE LEBANON ORE AND CONCENTRATES.

	Weight per cent.	Iron per cent.	Sulphur per cent.	Copper per cent.
Crude Ore	100	40	2.0	0.45
Concentrates	58	62	1.0	0.25
Tailings	42	8	8.5	1.20

SYD VARANGER (NORWAY).

The ore here is a low-grade magnetite, containing on an average only 34 per cent of iron. It is therefore a decided concentrating proposition. The company, which has been formed for the exploitation of this field and comprises mostly German and Swedish interests, has therefore thoroughly investigated the various concentrating processes that have been developed and has finally adopted the Gröndal wet process of concentration with the briquetting of the fine concentrates. A plant is now being built that will contain 12 parallel units (Figure 17) each preceded by a crude-ore bin, which delivers the ore by means of an automatic feeder to a jaw crusher. The crushed ore, now 1 inch to 1½ inches in size, is carried from the crusher house on conveyor belts to the distributing bins of the proper concentrating plant. Each unit of this consists of two Gröndal ball mills, two tandem separators, two Gröndal tube mills, and two finishing tandem separators. The grinding and separating capacity of each unit will be 300 tons per 24 hours, or about 3,600 tons for the whole plant, from which about 1,500 tons of concentrates will be obtained daily. To begin with, only one-third of this will be briquetted; the rest will be shipped in the form of fine concentrates. By the repeated grinding and concentrating procedure as described, the iron content is raised to 66 to 69 per cent. The final product will therefore be of exceptionally high grade. The total product will be exported to German iron works.

INDUSTRIAL APPLICATIONS OF REINFORCED CONCRETE.

By M. M. Sloan.

The review begun by this article will be followed by three additional papers taking up types of construction, details of floor, lintel, roof, and skylight design, and applications of reinforced concrete to equipment, foundations, reservoirs, and other of the less ordinary uses to which it may be adapted.—THE EDITORS.

THE development of the modern manufacturing plant has evolved requirements which could no longer be supplied by the "slow-burning" construction used so extensively for buildings of this character a decade ago.

Not only would it be difficult to meet these demands by means of slow-burning construction, but the supply of available timber is constantly decreasing, making it more difficult to obtain timbers of large dimensions and sound material.

The factor, however, which had the most to do with the development of reinforced concrete in factory construction was the necessity for an entirely fireproof structure at a minimum cost. The slow-burning structure had a few advantages over the old-fashioned joist-constructed building, but a fire once gaining headway in a factory of slow-burning construction was pretty sure to destroy the building.

Manufacturers, as their plants increased in size and importance, began to realize the impossibility of continuing the use of buildings which were of such a construction that should a conflagration occur on a floor it could not be confined to that portion of the building; and, at any rate, to meet this contingency they demanded a building which, even after a severe fire, would remain sufficiently intact to be quickly re-equipped, and made ready for resuming manufacture.

Besides this demand for a fireproof structure it was found that, as the factory buildings increased in size, and wide spans were demanded to accommodate improved machinery, it was impossible to obtain the necessary strength with yellow-pine beams and girders. The use of steel beams was never satisfactory in factory construction, as they had less fire-resisting qualities (unless fireproofed) than heavy timbers, and besides, there were complications with reference to the connections to the columns and the construction of the floors.

One of the greatest advantages of reinforced concrete for the construction of buildings in which moving machinery is installed is found in the rigidity of the structure when made of this material. The vibration in reinforced-concrete buildings, even when heavy machinery acts in unison, is very slight, and consequently the wear and tear incidental to mis-alignment is greatly reduced.

In one instance where a reinforced-concrete addition was made to a large printing house, constructed with a steel frame fireproofed with terra-cotta, the old building was materially braced by the addition, and vibration which was almost alarming in the old structure when the heavy lithographic presses were running was almost eliminated. Care was taken, of course, to anchor the old to the new structure by tie rods and fastenings well secured to the steel fabrication and well bedded in the concrete work.

In slow-burning construction considerable difficulty resulted from timber shrinkage, especially in buildings of the more economical construction, in which the beams were placed upon the tops of the girders. The level of the floors was uncertain after a few years, and this would seriously affect the setting of the machines; besides, the shafting was constantly out of alignment, causing additional friction, expense for repairs, and increased power for operation. Such difficulties are almost entirely avoided in reinforced-concrete structures, and their elimination goes a long way toward paying for the increased cost.

The qualities of rigidity and adaptability of form possessed by reinforced concrete add greatly to its usefulness as a structural material for industrial plants where the building is an integral part of the machine, and where portions of the structure exist entirely as a housing or frame for the machinery, and where other portions act as bins, hoppers, chutes, and shafts for containing or conveying the raw materials or finished products. It is in buildings of this class that reinforced concrete becomes the cheapest and at the same time the best material that can be used. It would not be possible to use the slow-burning type for such structures without the cost of expensive framing, and the other features would necessarily need be made of steel and would possess neither the durability nor the fireproof qualities of reinforced concrete.

In many manufacturing plants it is a necessary part of the structural plan to provide special rooms or floors for kilns, dryers, or shallow pans for water. Among these would be included buildings used for the manufacture of glue, or the catch basins or pans under the condenser coils of an ice-plant. In such instances reinforced con-

crete has become almost, if not quite, indispensable. For purposes of this kind it has the advantage of not being affected by heat, and it can readily be formed into, and made waterproof for, pans, reservoirs, or for waterproof floors. On account of its fireproof qualities it is also indispensable as a ceiling or floor over forge shops or departments in manufactures using open fires.

As previously stated, one important factor which influenced the development of reinforced-concrete construction, is the constant diminishing of the available supply of heavy timber and its deterioration in quality, with a corresponding change in the lumber grading, so that lumber supplied by the trade today as being of a certain grade would have been rejected immediately if supplied as being of that grade a few years ago. This deterioration in marketable lumber such as is used in the construction of manufactories and commercial buildings, together with the long delays incidental to its shipment from the southern States or other points remote from the site of the operation, frequently determines the use of reinforced concrete. In many instances where the heavy timbers necessary for the construction of a building were not available from local stock, the possible time of completion for a reinforced-concrete building was found to be less than that for the same building of slow-burning construction, this saving in the time of completion being due to avoidance of long freight delays in the shipment of the timbers from distant points. It can thus be readily realized that to some manufacturers the gain of two or three weeks in the completion of the building would more than offset the increased cost due to the use of reinforced concrete. This is more specifically true where the business is of a periodical nature, the activity of the plant being confined to certain times of the year when the raw material is available and when the output for the entire year must be made up in a few weeks time.

It is such causes as these, together with the reduction in the rate of insurance, that have led to the disregard of the increased cost and the consequent adoption of reinforced-concrete construction.

The development of the use of reinforced concrete for the construction of manufactories and commercial buildings has produced three distinct types of construction: namely, the all-reinforced-concrete building, the building with brick or masonry walls and reinforced-concrete floors, and the reinforced-concrete skeleton-structure type.

The first named construction employs reinforced concrete for the entire structure,—for both the walls and the floors,—and though it is used to a considerable extent, it is very doubtful whether a build-

ing of this kind can be constructed for the same cost as one in which bricks are used in building the walls. Besides, the appearance of the building is not generally good, unless extreme care is used in the construction of the work on account of the difficulty in obtaining a uniform color for the wall surfaces, and likewise because of defects occurring in casting the work. The matter of appearance, however, is frequently of secondary consideration, and in some localities where concrete materials are cheaper and where it is difficult to obtain good brick, and consequently good artisans for laying them, undoubtedly the all-reinforced-concrete building has advantages. Such a building, being monolithic, possesses greater rigidity than any other type of construction, when properly designed and reinforced. On the other hand, the all-reinforced-concrete building cannot be erected as rapidly as other types.

Figure 1 shows the front of a typical reinforced-concrete building of the better type, and illustrates the greatest possibilities in the use of reinforced concrete for the entire construction of an industrial building. The only way in which good results, as far as appearance is concerned, can be obtained in wall construction, is to break the surface of the wall by pilasters; and, by simple treatment of the spandrels between the pilasters, the monotony of the monolithic surface is destroyed. This is well illustrated in the figure which shows excellent architectural treatment.

It is usual in the construction of an all-reinforced-concrete building, as just stated, to provide piers or pilasters on the exterior of the wall, and it is customary to reinforce these with longitudinal rods or bars such as would be provided in a reinforced concrete column. The spandrels, or walls between the columns beneath the window sills, are then merely reinforced with small rods or bars, or, in some cases, with woven wire fabrics, so as to prevent shrinkage, and in many instances these spandrels are put in after the main structural parts have been cast. This saves some time in the erection of the building, and allows the use of more care in obtaining a neat finish on the spandrel walls.

Where the manufactory or commercial building is of moderate size, there is probably no better construction than the employment of brick piers and spandrels with reinforced-concrete floor construction. This type of building is popular because of the neat appearance, and because it is entirely fireproof, and by the use of wire-glass windows and good, hard brickwork laid up in cement mortar, it makes the most fire-proof, durable and also most pleasing appearance of any type of factory construction.

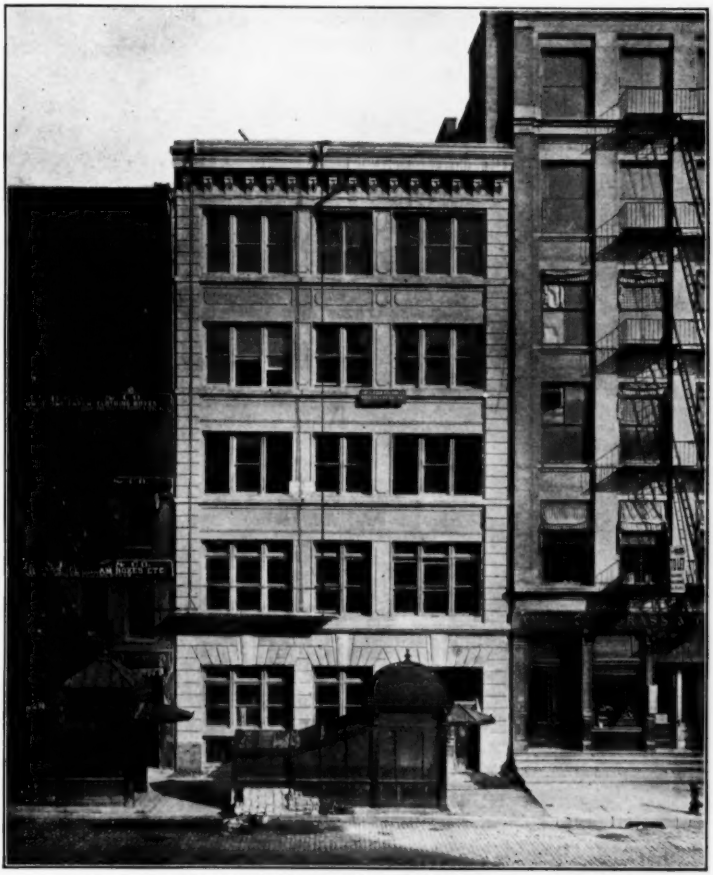


FIG. 1. TYPICAL REINFORCED-CONCRETE BUILDING OF GOOD TYPE.
Hollander building, New York. Kafka & Lindenmeyer, architects. Erected by Amsterdam Building Co.

Where a building of superior architectural appearance is required, the exterior face walls can be laid up in a good non-absorbent or sand-lime brick, with cast artificial-stone sills and trimmings, or terra cotta. Usually a factory building constructed after this type is arranged with wall piers of sufficient strength to carry the loads and spaced from twelve to sixteen feet apart, so that large twin or triple window openings can be provided between the piers. The concrete-frame type of construction is shown with the centering in place in Figure 2.

As the obtaining of the maximum amount of daylight is very desirable in factory buildings, the window frames are run as close as possible to the underside of the floor slab, and are detailed as shown in Figure 3. It will be noticed that to accomplish this, the beams supporting the floor slab must run parallel with the walls of the building so that none of the beams will take bearing on the lintel, and the lintel will support only the spandrel wall and the reinforced-concrete floor slab.

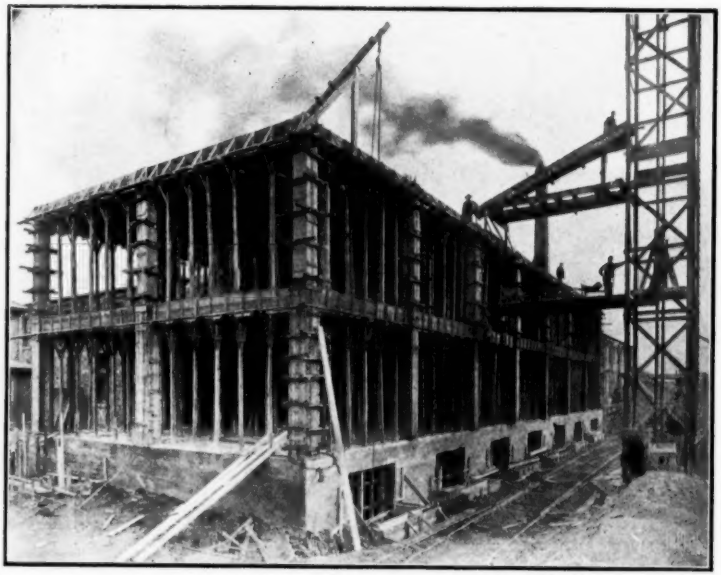


FIG. 2. REINFORCED-CONCRETE BUILDING, CONCRETE-FRAME TYPE, WITH CENTERING IN PLACE.
Republic Rubber Company's new building, Youngstown, O.; Nicola Building Co.

In arranging the framing plan of the building, the spacing of the beams is returned at the corner, as illustrated in Figure 4, so that the windows are the same height throughout, and a diagonal girder, as at A, returns the beams running lengthwise of the building so that in the last bay they are parallel with the end wall.

Where the manufactory or commercial building is from five to ten stories in height, and where it is desirable to have as much light area in window surface as possible, it is customary to run up a reinforced-concrete structural frame, having similar outlines to the usual steel-frame or skeleton construction. This concrete cage construction is carried up in advance of the rest of the work, and the brick facing and brick filling of spandrels and curtain walls is proceeded

with after the concrete cage has been completed, or the construction of it has proceeded to a considerable extent. By designing a building on these lines, the exterior wall piers can be made narrow, as the reinforced concrete composing their structural strength has a safe bearing value of at least 500 pounds to the square inch. Buildings of this type of construction can be made as ornamental in appearance as may be desired, as they are capable of extensive architectural treatment with face brick and ornamental terra cotta. Such a construction is well illustrated in Figure 5.

Nearly all the types of reinforced-concrete construction consist of reinforced-concrete columns, beams, and girders. This system of floor construction is almost universal, but in several instances the type of floor construction known as the "mushroom system" has been employed for warehouse work where it was desired to do away with the projecting beams and girders on account of the increased storage space provided. This type of construction employs a heavy slab supported by columns at close intervals, with reinforcing rods or bars run in several directions, and the column reinforcement is spread out at the top so as to relieve the slab as much as possible.

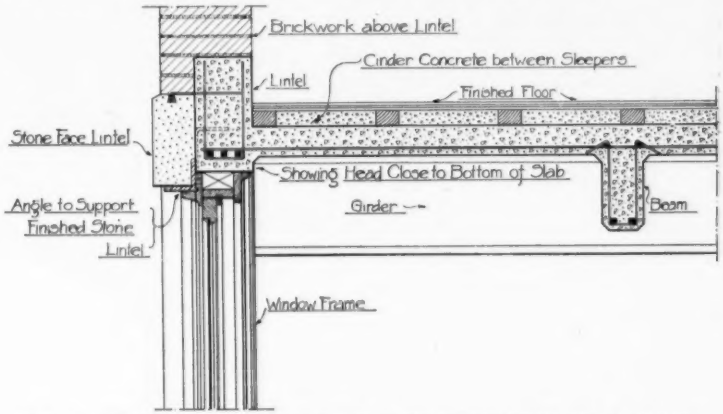


FIG. 3. DETAIL OF WINDOW-FRAME AND FLOOR-CONSTRUCTION FOR MAXIMUM LIGHTING EFFECT.

The constructors active in the development of reinforced concrete seemed at first to devote all of their attention to the steel reinforcement, and their efforts for a while were confined to the production of deformed bars, the idea being to produce reinforcing rods or bars having deformations which would give greater bond in the concrete. The result was that numerous rods or bars, having different characters of rollings, were produced, most of them possessing no advan-

FIG. 5. CONCRETE-CAGE CONSTRUCTION WITH BRICK FACING AND BRICK-FILLED SPANDRELS AND CURTAIN WALLS.
Maurice Lynch building, Uniontown, Pa. Nicola Building Co.

tage over other rods or bars, as in nearly all instances an effort was made to obtain a deformation to give greater bond in the concrete with the least use of material and the least reduction in the net section of the rod or bar.

While it is undoubtedly the best practice to use a deformed bar in reinforcing concrete, many buildings have been successfully constructed of plain round bars and have stood the vibration for a number of years. It is, however the universal practice to employ some character of deformed reinforcement for the steel in the beams, girders, and slabs. Most of the deformed rods or bars on the market are good types, though a square twisted bar usually has the advantage of being less costly.

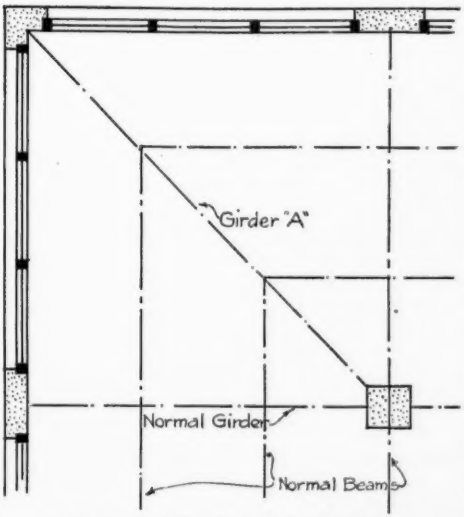


FIG. 4. FRAMING OF BEAMS AT CORNER.

Together with the development of the type of bar or rod, efforts were made to secure the rods or bars together and to tie them in with the secondary reinforcement, or stirrups, as they are commonly called. This effort developed what is known as the girder frame or type of reinforcement, and several systems of reinforcement were evolved along these lines. One of the best practices, however, is to use a loose rod or bar system, providing stirrups with hook ends so that they rest upon the slab forms and pass under the steel reinforcement, and to use with this loose rod or bar system small concrete blocks cast with beveled edges, which are placed in the forms underneath the rods or bars and so support them at the proper distance from the bottom of the form. These blocks of concrete incorporate with the concrete placed in the forms, and positively insure the location of the steel at the desired position.

It might seem that the girder-frame system of reinforcement is more desirable than this system, and where frames of this type are well designed they have many advantages. So frequently, however, they reach the site of the operation in such a dilapidated state that they require considerable adjustment before being placed in the forms. This defect inclines one towards the opinion that the system where the rods or bars are bent during operation and placed directly in the forms are as likely to result in as good work and as strong construction as girder frames; that is, with proper field inspection.

Of course the claim is made, for the girder-frame system of reinforcement, that the likelihood of having an improper amount of steel in the forms by the omission of the rod or bar is eliminated, and if their use accomplishes this they are well worth the small additional cost over and above the loose-rod system.

THE DESIGN, CONSTRUCTION AND OPERATION OF HIGH-LIFT CENTRIFUGAL PUMPS.

By Franz zur Nedden.

Mr. zur Nedden, who is a specialist in his subject, begins here a critical study that will be extended in following issues to cover the mechanical problems of construction and maintenance, construction and design, special types and applications, the selection of pumps for given duty, installation, operation and performance.—THE EDITORS.

THE excellent results obtained in the drainage of the silver mines of Horcajo, Spain, by the use of the then new Sulzer high-lift centrifugal pumps, were first published eight years ago. Today the superiority of the centrifugal pump from the point of view of practical management is thoroughly proven, especially in mining work. Many of the greatest firms in the world have taken up the construction of this type, and although in this branch of engineering especially professional secrets have been anxiously and successfully guarded, it is safe to say that types have become standardized. Practical experience has proved what is best. The question what type of centrifugal pump is best suited to any given set of working conditions is substantially decided. It is not the purpose of this study to attempt the impossible undertaking of presenting a general review of existing systems of high-lift centrifugal pumps. The more important object is to point out those features of the best types produced to which belongs the credit for the perfect performance of this form of pump. Beyond this, an effort will be made to show by the aid of diagrams what particular points must be considered in selecting and ordering a high-lift centrifugal pump for any given duty.

THE CHARACTER OF HIGH-LIFT CENTRIFUGAL PUMPS.

The earlier centrifugal pumps were inferior in efficiency and head. Their development into extremely economical machines, which though they occupy but small space are of high lifting power, has been effected through the device of constructing an apparatus by which the high final velocity of the water lifting the impellers is economically transformed into pressure. A thread of water entering the interior of an impeller at A, Figure 1, is seized by the impeller blades and flung outward. The energy transmitted to the water appears partly in the

form of hydrostatic pressure and partly in the form of velocity, the percentage of each depending on the form of the individual blades. Even those impellers which give the water the highest percentage of hydrostatic pressure must release the water at B with a velocity exceeding the peripheral speed. The total energy transmitted to the water is a direct function of the peripheral velocity of the impellers. It is clear, then, that economical transformation of the absolute velocity at the circumference of the impellers into pressure is of importance increasing with the amount of energy imparted to a single wheel. The conditions may be illustrated in a schematic way merely by Figure 2. If we take the energy transmitted to the water as ordinates, and the absolute distance traversed by the water drops as abscissas, it is clear that at A (the zero point of the system) no energy is yet transmitted to the water. As the water proceeds on its way through the impeller blades, the total of energy imparted to it progressively rises. At the point of emergence from the impeller B, all the energy (ordinate B C) has been transmitted; it exists partly in the form of hydrostatic pressure (C D), partly in the form of velocity (D B′) and a certain amount (B B′) will be lost in the form of friction losses, etc., represented by the hatched area A B B′. The speed energy has nearly all been lost in vortices through the lack of sufficiently smooth transformation, and the whole efficiency of the wheel is equal to the proportion $\frac{D\ C}{B\ C}$ or if the whole of the energy be called unity, the efficiency of the pump will equal D C.

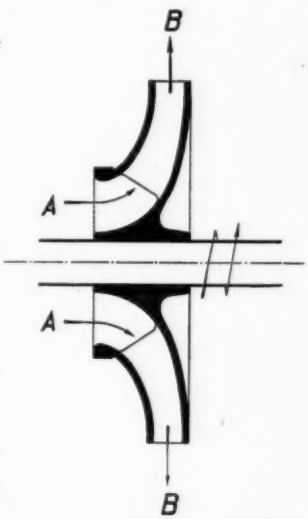


FIG. 1. ACTION OF THE IMPELLER.

The conclusive step was to catch the water leaving the impeller in channels whose cross section increases so gradually as to effect a perfectly moderate decrease of the water velocity. The particles of water must lose their resemblance to a troop of colts dashing out of their corral, and take on the aspect of a carefully harnessed team of horses. Each drop or particle leaving the impeller feels immediately the resistance of the drop directly in front of it, which, on account of a slight increase in the area of the channel, has begun to flow with less speed, yet not so slowly that the faster moving drop can force its way

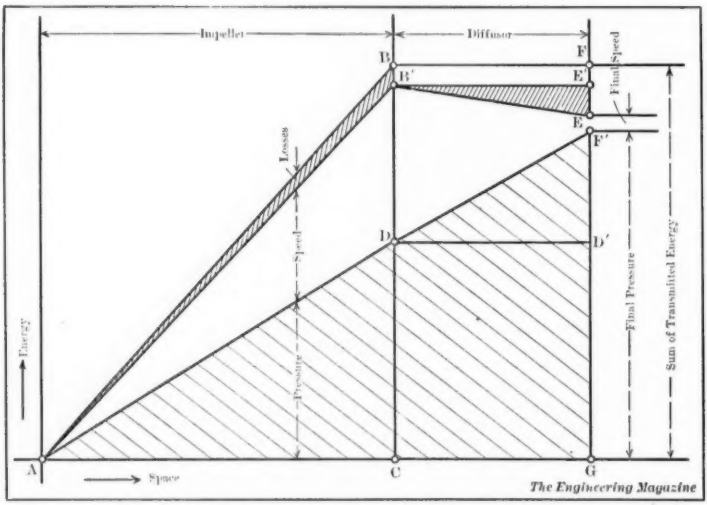


FIG. 2. ENERGY TRANSMISSION IN A SINGLE-STAGE HIGH-LIFT TURBO-PUMP.

between the slower ones ahead of it. Regular planes of equal velocity (or equal pressure) are formed perpendicularly to the axis of the channel. Thus the live energy of the drops crowding after is changed almost perfectly into hydrostatic pressure through the reaction of the drops that have been already retarded. If this transformation were effected absolutely without loss the whole sum of energy C B′ (Figure 2) would remain constant from B′ to E′, for no additional energy is supplied to the water after it has left the impeller. But here, again, a part of the energy will be lost through friction, etc., during the flow through the guide channels (area B′ E′ E). Leaving that out of consideration, however, the decrease of speed energy B D is attended by an addition of static pressure to the pressure C D. At the point E there remains only the velocity indispensable for the flow of the water into the pipes. The rest, F′ D′, is changed into hydrostatic pressure, thus giving us finally the ratio

$$\frac{F'\ D'}{E'\ D'}$$

as the expression of the efficiency of the guide channels. In comparison with the old centrifugal pumps without guide channels (diffusers) the efficiency has been raised from D C to F′ G.

The possibility of overcoming great heads economically with a single wheel has a very distinct limit in practical operation. The en-

tire amount of energy that we can transmit with one rotor is limited by a certain peripheral velocity. Even before we reach the point where the centrifugal stress is greater than the safe working strength of good materials, we meet the danger of erosion by fine mechanical impurities or even by the clear water itself. Especial care on the part of constructors is necessary in dealing with the water usually to be pumped from mines. A head of 300 feet is generally the utmost capacity of a single wheel.

Overcoming still greater heads with one centrifugal pump is made possible by a special constructive arrangement, which is the coupling of several rotors in series in a single casting. Figure 3 shows the course of energy transmission for a three-stage pump. The first part, abscissa zero to G, is simply the reduced reproduction of Figure 2. At G, instead of flowing into the pipes, the water enters the second impeller which is connected with a second guide wheel, and is thus carried to G_1, and so on in like manner through the third stage. In each rotor exactly the same process is repeated.

A question of great importance is whether the efficiency of the process is altered by this multi-stage arrangement. The diagram answers it with great simplicity; geometric homology shows that the total efficiency is

$$\frac{F_2\ G_2}{A_3\ G_2} = \frac{F'\ G}{A_1\ G}$$

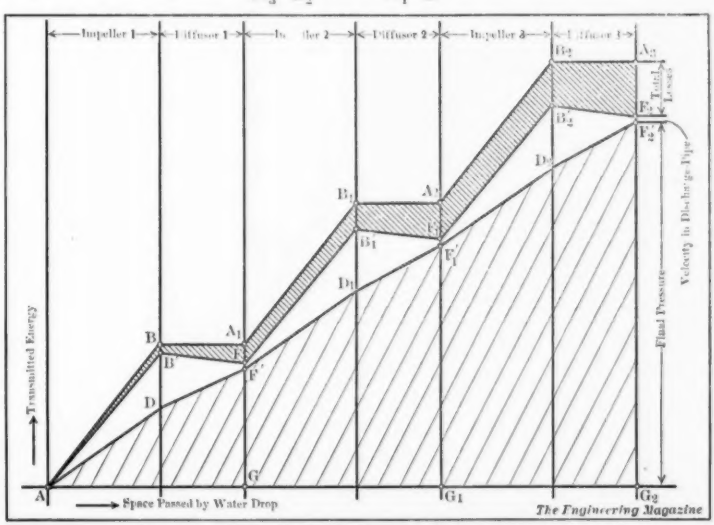


FIG. 3. ENERGY DIAGRAM OF A THREE-STAGE TURBO-PUMP.

The Losses in High-Lift Centrifugal Pumps.

The results obtained by this general consideration remain correct on a more intimate examination of the individual sources of losses in the interior of multi-stage turbo-pumps. In general, we must distinguish between mere mechanical and hydraulic losses.

Pure Mechanical Losses.—Besides friction in the bearings and stuffing boxes, the principal loss is the energy expended in the rapid movement of the impellers through the surrounding water, even if their surfaces are most highly polished. This energy can not be calculated exactly with our present knowledge. It has been certainly proved only that it increases with the square of the number of revolutions and with the fifth power of the diameter. This peculiarity of the rotor-friction loss is of fundamental importance in the entire development of high-lift turbo-pumps. First, it follows therefrom that it is wiser to run small discs rapidly than large ones slowly. For this reason electrical driving, and especially driving by high-speed motors, (that is, by the smallest and cheapest type) is most convenient. By this contrast to the piston pump, which is bitterly unfriendly to rapid revolution, the turbo-pump must always be superior when electric current, and especially three-phase alternating current, is available. This is the leading reason for the triumphant success of the new system.

The peculiarity of the rotor-friction loss just mentioned is decisive secondly in fixing the number of stages. Of course with a single wheel, as, for instance, a wheel of 1 foot diameter and 1,500 revolutions per minute, we can force 500 gallons per minute to a head of about 100 feet with the same hydraulic perfection as if we forced but 250 gallons to the same head. But it appears that the 250-gallon wheel gives an efficiency of 65 per cent, whereas the 500-gallon wheel gives an efficiency of 73.5 per cent. The relation is very simple. The 250-gallon impeller produces a net water power of about

$$\frac{250 \times 10 \times 100}{60 \times 550} = 76 \text{ horse power.}$$

and it consumes for its operation $76 \div 0.65 = 117$ horse power. Its total loss, therefore, amounts to $117 - 76 = 41$ horse power. One-third of this, or about 14 horse power, may be attributed to other sources of loss; the remaining 27 horse power mean rotor-friction loss.

The 500-gallon wheel produces a net water power of about

$$\frac{500 \times 10 \times 100}{60 \times 550} = 152 \text{ horse power.}$$

that is, double the water power of the 250-gallon wheel. But the rotor-friction loss remains exactly the same as with the 250-gallon wheel, as the friction areas in both cases are the same. The other losses will grow in rough proportion to the capacity, that is, will be doubled. Thus, the calculation for the driving power consumed gives us $152 + (2 \times 14) + 27 = 207$ horse power, and the efficiency will be $152 \div 207 = 73.5$ per cent. These figures agree fairly well with actual results. They demonstrate the importance of the power loss due to the friction caused by rotation of the impeller in the surrounding water, and this indeed becomes decisive in the first step of turbo-pump manufacture on a large scale—that is, selection of standard sizes. It is evident at a glance that, even using wheels which are hydraulically most perfect, it is impossible to raise small quantities of water to great heights without considerable loss. For small capacities (say about 25 gallons per minute) the constructor must use comparatively small rotors, and hence for the same number of revolutions, small heads for each stage, in order to get a pump of even tolerable efficiency. As the quantity of water delivered is increased, the head which may be economically allowed for each stage increases nearly in proportion. Within the limits of a constant number of revolutions (as, for example, 1450, the speed best suited to motors driven by three-phase alternating current of 50 cycles). the ratio "quantity ÷ head per stage" which gives the best working results will remain approximately constant. Thus we find, for instance, that a turbo-pump of 100 gallons per minute capacity at 300 feet head must have ten stages, while 1,000 gallons may be lifted nearly to the same head with a single wheel. There is naturally a strong temptation to constructors to alter this ratio $Q \div H$ in their favor by increasing the number of revolutions. If we double the rotative speed the motor diameter must be decreased to $\frac{1}{\sqrt{2}}$ of its former proportion if we are to keep the same head per stage. The friction loss, decreasing as the fifth power of the diameter but increasing only with the square of the number of revolutions, will become a smaller percentage of the total losses with the high-speed rotor.

To revert to the example quoted just above: The lift of 100 feet

could be effected by a single wheel one foot in diameter at 1,450 revolutions per minute; at 2,900 revolutions the diameter of the rotor need be but $\frac{1}{\sqrt{2}}$ foot, that is, 8½ inches. The rotor friction loss amounting to about 27 horse power at 1,450 revolutions per minute will diminish in the proportion $(8\frac{1}{2})^5 \div 12^5$, which ratio is equal to 0.18. At the same time it will be increased in the ratio $2{,}900^2 \div 1{,}450^2$, which is equal to 4. The new value of this friction loss will then be $27 \times 0.18 \times 4 = 19.5$ horse power. The other losses are not much affected by the change of speed, as we shall see later on. Thus, the new total losses are $14 + 19.5 = 33.5$ horse power. For a delivery of 250 gallons per minute the efficiency of the stage will be increased to $76 \div (76 + 33.5) = 70$ per cent.

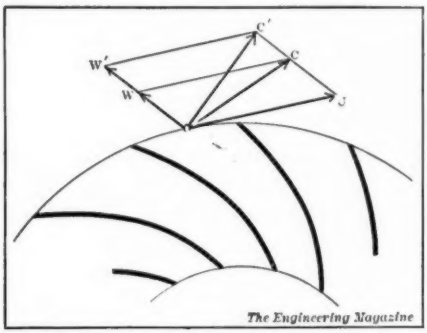


FIG. 4. VELOCITY OF WATER LEAVING IMPELLER.

It yet remains to be decided, however, whether practice can accommodate the constructors' wishes for very high rotative speed. High-speed motors of large capacity especially have not yet been constructed — motors up to about 3,000 revolutions. With medium-sized combinations, even, the introduction of very high speeds today unquestionably involves diminution of security in operation. Runners of this high rotative speed might be desirable for a well-attended central station, but not for mine service where often machinery can not be properly kept up. Above all, theory alone opposes some serious objections. We shall understand these if we now turn to the second group of losses in the interior of the turbo-pump, that is, purely hydraulic losses.

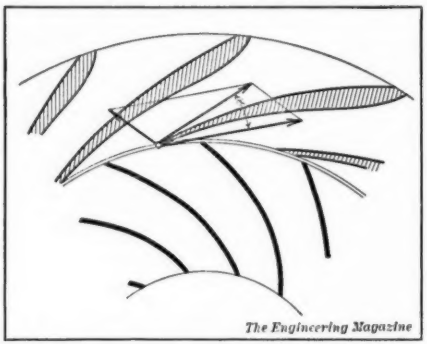


FIG. 5. IMPELLER DISCHARGE WITH RELATION TO GUIDE-BLADE ANGLE.

HYDRAULIC LOSSES.—If we examine a particle of water leaving the impeller after it has been accelerated we see that it first shares the tangential velocity of the impeller (U, Figure 4); and second, by the flow through the moving channels of the rotor it is given a relative velocity, W, as compared with the wheel. This relative speed depends on the cross section of the channel and the quantity of water passing through it per second. The direction coincides with the axis of the channel. Both are combined in the resultant absolute velocity C. The tangential velocity and the cross section of the channels remain constant with the same wheel and the same number of revolutions. Thus the value of the relative velocity W alone changes, and that proportionally to the quantity of water flowing through the pump. Thus, a larger flow, for example, will produce the relative velocity W′, and the absolute velocity is changed in value and in direction to C′. With reduced quantities of water the angle and magnitude of C differ again in the opposite direction. Turbo-pump wheels of course work best from the hydraulic point of view if the transition from rotor to guide wheel is free from impact—that is, if the direction of the absolute velocity of the water coincides with the axis of the guide channels.

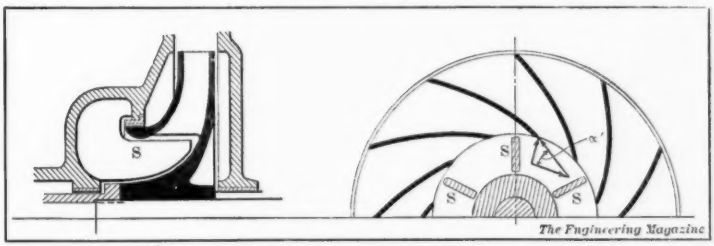


FIG. 6. INFLOW OF WATER TO THE ROTOR.

This indicates for the form of the guide blades a condition of tangential junction to the direction C (Figure 5). The latest types of high-lift centrifugal pumps all have fixed guide blades. The condition of impactless movement of the water consequently is fulfilled theoretically only for a single rate of discharge—the so-called normal quantity. It must be emphasized that many constructors have vainly endeavored to equip turbo-pumps with movable guide blades after the pattern of the Francis turbine. They failed because of the structural clumsiness of the mechanism, especially with multi-stage pumps. It is true that avoidance of impact for more than a single rate of discharge can be secured by this arrangement, but it would be a mistake to expect any large improvement in efficiency in the delivery of quantities approximating the normal, for the losses caused by impact are

still but small in comparison, for instance, with the rotor friction loss. They become considerable only at a rather large variation of the delivery—that is, of the angle a, Figure 5—from the normal value. Furthermore, there are other ways of checking the impact to a great extent.

Similar shocks occur at the impeller entrance. A purely radial inflow is generally assumed here, and the speed diagram at the entrance to the rotor conforms to that developed in Figure 6. The proper angle for the first elements of the impeller blades becomes a'. The assumption of radial inflow affords the best utilization of the available area, that is, a minimum inflow speed, maximum of allowable suction head, and similar advantages. Some constructors try to obtain this radial direction of inflow by the use of special entrance blades (S S, Figure 6). In this case, an abnormal delivery will effect a real impact loss by deflection of the angle a', corresponding closely to the similar shock in transition from rotor to guide wheel. If no guide blades govern the entrance, with continuous abnormal delivery the inflowing water will fail to take the ideal (radial) path. Consequently the terminal elements of the suction column themselves begin to rotate, and the increased friction on the walls of the casing through which the water passes presents the equivalent of impact loss. However, whether this entrance loss be occasioned by shock or increased friction, it is much smaller than the impact losses at the entrance to the guide wheel; for at the rotor entrance we have normal speeds of about 6 feet per second, while at the passage from impeller to guide wheel the velocity is as high as 120 feet per second, and the losses from shock are proportional to the square of the speed.

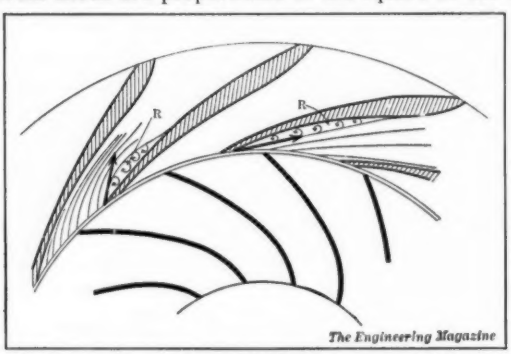


FIG. 7. VORTICES CAUSED BY VARIANCE BETWEEN ANGLE OF ABSOLUTE VELOCITY OF WATER AND ANGLE OF GUIDE BLADE.

These direct impact losses are increased by those arising indirectly from the same cause. For example, at the entrance into the guide wheel the outflowing water strives to leave the front or the back of the guide blade, as the case

may be, whenever the angle of its absolute velocity varies from the tangent of the entrance elements of the guide blades. An area of whirling dead water (R R, Figure 7) is thus formed. Similar phenomena may appear in the interior of the impeller when the blades are incorrectly shaped and the delivery differs considerably from the normal. Shock and vortex losses are at a minimum at normal delivery and reach their maximum at the extremes of underload or overload.

Beyond this, account must be taken of the pure friction losses caused by the flow of the fluid through the channels, especially at very high speeds. These losses are proportional to the square of the relative velocity in the rotor and of the absolute velocity in the guide wheel and casing. They are nothing at the zero point of delivery and reach their maximum with the greatest possible output.

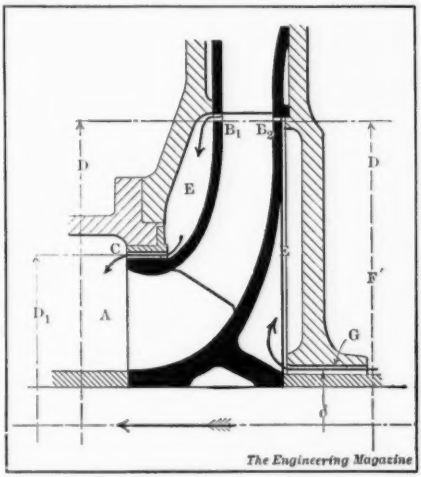


FIG. 8. LOCATION OF LEAKAGE LOSSES.

Losses so far discussed cause a diminution of the head. Losses occasioned by the unavoidable inner leakages lower the volumetric efficiency. Figure 8 shows that it is impossible to prevent leakage at the following places:

1.—At the clearance between impeller and guide wheel (B_1 and B_2).

2.—At C, between the chamber E (which is full with water under pressure leaking through the clearance B_1) and the entrance chamber A.

3.—In multi-stage pumps, at G between the chamber E and the entrance chamber F' of the next stage.

Figure 2 shows clearly the pressures in the separate chambers. Chamber A has the initial pressure of the stage; chamber E, the increased pressure D C, produced at the periphery of the rotor; chamber F' is filled at the ultimate pressure of the stage F' G, which has been augmented by the guide wheel by the amount F' D'. The arrows in

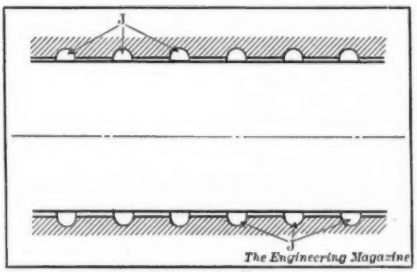


FIG. 9. "LABYRINTH" BEARING.

Figure 8 show the directions of the pressures. It is apparent that the clearance between rotor and guide wheel at B_1 B_2 is unimportant so long as the joints at C and G fulfill their duty; for the pressure in chamber E will instantly assume the value C D (Figure 2) and thereafter there will be no further tendency for leakage at right angles to the flow of the water at B_1 B_2. The clearance B_1 will thereafter have to make good only the leakage loss at C. A further influence checking clearance loss is that due to the simultaneous rotation of the contents of chamber E. Gyroscopic pressures are thus generated in chamber E, which are highest in the immediate neighborhood of the rotor and work in opposition to the outward pressure at the clearance. To these favorable circumstances constructors owe the ability to keep the leakage losses in the interior of the centrifugal pump almost infinitesimal.

The problem of internal tightness is governed further by the celebrated experimental results obtained by Poiseuille* and lately confirmed by Dr. Ing. Becker.† These prove that leakage loss is proportional to the cross section and inversely proportional to the length of the clearances. It follows, therefore, that, given equal skill in shop construction, the minimum of leakage will attend that form of construction in which the bearings C and G are given the smallest diameters. "Labyrinths" like Figure 9, which have given excellent results with steam turbines, are useless with turbo-pumps. Their effectiveness is based on the expansion of steam in the spaces J J. Incompressible liquids, on the contrary, give only dead-water vortices at these points. The water passing through the bearing flows without any disturbance at all through the space J and onward.

* Poiseuille: Recherches Expérimentales sur le Mouvement des liquides. Paris, 1844.

† Becker, Strömungsvorgänge in ring förmigen Spalten und ihre Beziehungen zum Poiseuilleschen Gesetz. Berlin Verein Deutscher Ingenieure Forschungsarbeiten, Heft 48, 1907.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," the second to "Production Factors as Related to Cost Accounts and Staff," and the third to "The Elements of Land Factor."—THE EDITORS.

IV. BUILDINGS, HEATING AND VENTILATION, STORES, AND ORGANISATION.

AFTER land, buildings come next in sequence. Few operations are carried on in the open air, and all but the roughest kind of storage is usually sheltered. Normally, therefore, the land factor is merged in a buildings factor, and does not itself pass into the machine rate of a production centre.

The elements of a buildings factor comprise *all charges for the maintenance of the building as a factory*, including not only rent charges or their equivalent in interest and depreciation on capital expenditure, but also the expenses of repairing, maintaining, painting, whitewashing and cleaning. These charges which are in the nature of rent present the most complication, inasmuch as their bases vary greatly according to circumstances, depending on whether the building is leased or owned.

The former is the simplest case. Where a factory is held on simple lease, the annual rent paid represents the whole of the rent charge. In such cases the land factor does not appear, for it is implied in the rent paid to the landlord, which includes it. Where a dilapidation clause is in force that compels the tenant to hand over the building in original condition at the end of his tenancy, provision for this must be made by means of a sinking fund or at least a reserve account. Otherwise the chief elements of a buildings factor are the following:—

Landlord's rent.
Amortisation of lease (if any).
Rates and taxes.
} A land factor is implied in these, but is not of course distinguishable.

Insurance on building.
Annual cost of repairs and maintenance.
Annual cost of painting and whitewashing.
Annual cost of cleaning.

In cases where the land has been purchased (and its value reduced to a land factor) and buildings have been erected by the manufacturer, the elements are naturally different. Instead of a simple rent charge we have to take into account the land factor as representing rental of land and interest and depreciation on the building that has been erected. The principal elements will then be:—

Land factor. Interest on capital value of building. Depreciation of building.	These three elements are equivalent to landlord's rent, and amortisation, (if any).
Rates and taxes. Insurance on building. Annual cost of repairs. Annual cost of painting, etc. Annual cost of cleaning.	As before.

These items will, of course, be assessed separately for each building. In this case no averaging (as between buildings) can be permitted. Every separate building will have peculiarities, and only by recognising these can a true buildings factor be obtained. Thus, the power house (with which will be included a separate assessment for the factory chimney stack), the shops, foundry, pattern stores, offices, and warehouse will all be found to have different buildings factors representing the true annual charge for accommodation of the operations carried on in them. Some buildings will be of one story and some of several stories. In a long established factory some will be old, and carry a heavy annual charge for repairs and maintenance, and some will be new, with a small charge. The separate annual values brought out by the factor method will force the question of buildings-efficiency prominently into notice. In one respect buildings and all other factors of production differ from land, in the case of which, it will be remembered, the principle of averaging was to a certain extent admitted. The diverse annual charges on adjacent sites were aggregated and averaged in certain circumstances, and this was allowable *because the incidence of land charges cannot be reduced by any improvement or change of policy.* There is nothing individual about the different portions of a level site, and nothing that can be modified or reorganised. But in every other case we are dealing with artificial structures or arrangements capable of alteration and improvement in efficiency. It is the object of the production-factor method to keep the charges on each such element of production separate and localised so that its true bearing on production is exhibited and its efficiency made manifest.

It will be noticed that three of the items of the buildings factor are estimated, or rather forecast. Those for painting, whitewashing and cleaning will present no difficulty, but the annual charge for repairs requires careful determination. This should be an annual average charge based not upon the accidental circumstances of any one year, but on what is spent or likely to be spent one year with another. The object of this is to give a steady figure, representing real annual cost, and not a violently fluctuating one that affects costs in a meaningless way. Any discrepancy between the amount *actually* expended in any one year and the amount *forecast* in the buildings factor will be dealt with in a way that will be discussed when the general bearing of the method on costs is discussed.

It will now be obvious that we are in a position to ascertain with close accuracy what is the actual out-of-pocket cost per annum of each separate building forming part of the undertaking. Such annual cost will be that of each building as a "going concern," maintained in a condition ready for use for any purpose required. In this way we have already reduced considerable groups of expenditure to perfectly definite issues, and by dividing the total *available* floor space of each building into the annual cost of such building we arrive at a rent per square yard that necessarily represents the cost due to land and buildings in every operation carried out on any of those square yards.

In determining *available* floor space only such areas are reckoned as can be used productively. Thus, galleries, landings, passages and stairways are omitted from the divisor, which consists solely of what may be termed the net area. Whether such net available area is actually occupied by production centres does not affect the matter. We have to proceed as if the buildings were empty and assess their net *capacity* for use, not their actual use. The actual use may speedily be seen to be wasteful and inefficient, once all the factors of each production centre are determined.

In some cases reduction to annual cost per square yard is not required for the purpose of costing, but it should always be done as establishing a unit value for comparison with the similar buildings of other undertakings. This will apply to the power house in most cases, and to the buildings used for stores and for offices. The reason will be seen when we come to deal with those departments.

The Power Factor.

Having now established the cost factor of buildings ready for occupation on a basis which may be used for machine-rate assess-

ment, the reduction of the power service to an equally assessable basis is the next most important step. The elements of the power service are many and include every expenditure relating to the generation and distribution of power and its delivery at the point of application. The total of such expenditure when collected is reduced ultimately to a factor of production-centre machine rates on this basis.

The simplest conditions governing the power factor are those obtaining when a city or power-company's current is used direct and the whole installation, motors included, is hired. The charge per kilowatt-hour, or per horse-power hour, becomes then the power factor without any further trouble, and so enters into the machine rate.

This case is interesting as showing all charges merged of necessity into *a simple rent for a particular service to production*—viz., power supply, the whole object of the production-factor method being to reduce the cost of a number of other heterogeneous services to simple rents in the same way. That the manufacturer undertakes to make his own current or supply himself with his own power is no good reason for not ascertaining what it costs him in the form of a definite rate, just as if he had purchased it from outside. Indeed it is the very best reason for reducing his power expenditure to such a rate.

The next simplest condition is where current is purchased, but all the transmission and distribution appliances are the property of and are maintained by the manufacturer. In such cases the elements are as follows:—

1. Interest
2. Depreciation } of { Motors, switchboards, cables, meters, switches, shafting, pulleys, belting etc.
3. Maintenance
4. Annual cost of current.

N. B. The cost of maintenance includes repairs, attendance and all similar expenses.

The annual charge for each of these elements having been determined, the total cost divided by the number of horse power actually consumed will give, as before, the cost per horse power as delivered and used at the production centres.

Where the current is not used as received, but is taken at a high voltage and transformed, or taken alternating and converted to direct, the annual charges for the transforming station must be added to the above. They will consist of:—

5. Buildings factor of station.
6. Interest and depreciation on transforming plant.
7. Maintenance of transforming plant.

In the majority of factories, however, the ramifications of the power service are much more extensive than this. One, two or more centres of power generation may be employed. A central boiler plant may serve to feed scattered steam engines. The transmission system may be partly mechanical and partly electrical. It may include pneumatic and hydraulic installations for special purposes. Water power may be used at one period of the year, and replaced or supplemented by steam power at another. There is, in fact, scarcely any limit to the variety and complexity which the power service may present. It will be obvious that it would take a considerable volume to deal with the proper treatment of all possible combinations. Fortunately this detailed treatment is not necessary, for the underlying principles are simple, and the most complex practical arrangement differs only in degree from the case of rented electrical power just given.

Power costs must not be averaged. If there is more than one centre of generation, or if with one such centre there are several kinds of transmission, or even several main directions of supply of one kind of transmission, each of these must be carefully traced down and its power delivery cost worked out separately. Only in this way can the essential advantage of production factors—the localising and isolating of so-called indirect expenses—be attained.

Briefly summarised, the elements of any kind of power service will be mainly these:—

1. Buildings.
   (a). Where plant is erected without roofs or walls, as cooling towers or softeners, the land factor of area occupied takes the place of a buildings factor.
   (b). Where plant is erected in buildings, as boiler houses, engine houses, pumping house, etc., the buildings factor will be first determined in the usual way.
2. Generating plant.
   Buildings factors and land factors concerned.
   Interest and depreciation on engines, boilers, and on all auxiliary plant.
   Fuel, including delivery, storage, stoking and ash removal.
   Maintenance and repair including labour.
   Cost of water, softening chemicals, etc.
   Oil, grease, waste, etc.
   Labour and attendance.
3. Transmission plant.
   (a). If electrical,
      Same elements as supply from city mains (above) but including interest, depreciation and maintenance of dynamos.
   (b). If mechanical,
      Interest depreciation and maintenance of clutch gears, shafting, pulleys, belts, etc.

N. B. Maintenance includes lubrication, and materials therefor.

The best guide to the proper procedure for determining power factors will be the considerations developed in the opening articles and above referred to, viz:—that *the function of the manufacturer as a supplier of power has no relation to his manufacturing function other than in respect to the cost of the power so supplied to himself.* The object sought is therefore the isolation of all expenditure arising out of this special supplying function. Once this principle—and it is simple enough—is thoroughly grasped, the disentanglement of the charges belonging to the most complex and involved system of power supply will present few difficulties to a person technically competent. The total cost of all kinds being arrived at, its division by the total horse power consumed—the aggregate of consumption by all machines during the working hours of the year—will give a horse-power-year rate that becomes a factor of each machine rate and represents the cost of power on any kind of operation performed by a production centre, from planing an engine baseplate to turning a thousand studs on an automatic machine. The actual way in which the power factor is used in machine rates will be dealt with in the next article.

Lighting.

Electric lighting being very generally in use in modern works, and being derived from the power plant, this factor is usually intimately connected with power, but to begin with and to exhibit the principle in a concrete form, the case of a factory using gas taken from the mains and consumed both in small lights and in large regenerative shop lights will be taken.

The settlement of unit value of light is made on a basis similar to that of the buildings factor, viz., on a capacity-area. Lighting, however, may be both general and individual. The general lighting of the shop may require supplementing by individual lights for particular production centres. The cost of such lights is of course deducted from the general lighting cost, and applied as will be discussed when Machine Rates are considered.

In the case of shops lighted by gas, the factorial elements will be:—

1. Interest and depreciation on the lamps and suspension tackle, and on the mains, valves and pipes.
2. Maintenance of ditto, including attendance and repair.
3. Cost of gas.

These figures are collected separately for each building. Each shop bears its own proper proportion of exceptional features. Thus in the case of an isolated building requiring a long special main, the

annual charges on this main would be borne by the shop for whose benefit it was maintained.

Where electricity from the firm's own plant is supplied the problem is varied only in form and details. Cables take the place of pipes, and current of gas. Interest, depreciation and maintenance of the special dynamo should of course be included in the cost of electricity. Whether or not the ordinary factor is used to represent cost of power depends upon circumstances. The primary object of a plant being to provide power for the shops, the use of current for lighting might sometimes be considered in the light of a bye-product of the general power supply. The relatively small call for lighting raises the average load on the engine, but the extra *cost* of such additional output may be in small proportion to the lighting energy supplied. This is a matter for practical determination and estimate in each case. Some interesting hints will be found in an article by Mr. P. R. Moses in these pages, "The Electric Equipment of Workshops."* The same writer's article on "Power Equipment for the Small Factory"† may also be consulted.

On whatever system lighting is effected, its separate cost for each building will be fairly simple on these lines. Having arrived at such separate annual cost, division by the capacity-area of each building will give the unit cost per square yard per annum. This unit cost enters directly into the machine rate as a factor.

Heating and Ventilating.

Heating and ventilating may be considered as opposite sides of the same problem, namely the maintenance of an atmosphere of pure air at uniform temperature in the shops. In as far as ventilation is a matter of building construction it has of course no assessable value for our present purpose. But where special mechanism is involved—blowers, fans, piping and mechanical ventilating appliances—these form a separate and consequently assessable service to production. Heating methods being always artificial necessarily form an assessable service in every case.

It must be remembered that we are dealing here with the general or regulative aspects of both heating and ventilation. Either of these as a process forms part of the direct equipment of production centres and will be dealt with when the consideration of machine rates is

* The Engineering Magazine, September, 1904.
† The Engineering Magazine, March, 1908.

entered upon. Examples of these latter applications are tempering and hardening furnaces, and exhausting appliances in connection with emery grinding. They have nothing to do with the present problem.

In the United States, warm-air heating is in much more general use than in Europe. In many British factories slow-combustion stoves conveniently located about the shops supply all the heat necessary. The cost of such heating is represented mainly by cost of fuel and labourers' time in stoking and attendance. Generally speaking British and to some extent Continental preference is for radiated heat while Americans adopt convected heat.

In either case reduction to unit-value per capacity area of buildings heated must proceed upon the same lines. In the case of stoves and all similar self-contained heating appliances the problem is too obvious to need discussion. Where steam pipes and local radiators are in use the elements of the heating factor for any building are mainly as follows:—

1. Interest, depreciation and maintenance of pipes and radiators.
2. Value of steam consumed.

Where a special boiler is used to generate steam, its value is added to item 1 and cost of fuel takes the place of item 2. Where convected heat is employed, the problem is much the same. Fuel applied to the coils of the heater takes the place of cost of steam in item 2. Specially expensive arrangements for any shop, as, for example long lengths of main pipe to isolated shops, will fall on the shops for which the expense is incurred.

The total cost of heating the shop during an average year being ascertained, this amount is divided by the capacity-area of the building. The result will be a unit value per square yard heated. This involves the assumption that one year will be much like another in its call on the heating apparatus. It must not be forgotten however that heat is required over a portion of the year only, while its incidence is spread over the whole year. Unless therefore in the case of an altogether exceptionally long and severe winter the discrepancy between the estimated and the actual expenditure per average day throughout the year would be negligible. Nevertheless the item should be carefully watched to see that any discrepancy is kept within bounds. How this is done will be shown later.

Where ventilating installations comprise piping, fans, and mechanical devices they are dealt with in the same way and on the same

basis as heating, power for driving fans being substituted for cost of steam or fuel.

Stores and Transport.

Up to this point we have been dealing with production factors in which reduction to unit cost on a floor-area or horse-power basis will be a tolerably familiar idea to most manufacturers. We have now to consider a quite different class of expenses that hitherto it has never been attempted to group together naturally, still less to express as a definite and assessable factor of cost. The heading of this section gives the key-note of the procedure, viz., that the expenditure incurred in storing, handling, transporting and delivering raw materials is capable of being separated out from all other expenditure and considered as having its own special incidence on production.

It must be emphasised at the outset that transport implies here, the handling of materials *in course of manufacture* alone. It does not for instance, include the handling and transporting of coal or the conveying and dumping of ashes and clinker, all of which operations fall within the province of the power factor. Nor has it to do with the freightage and delivery of the finished product, except into warehouse in the case of a product that is regularly stocked for sale. The word "stores" here means raw and partly finished materials, as distinguished from "stock" which represents finished and saleable goods.

A comparatively brief examination of the question will serve to show that the movement of raw materials (1) in and about the place of storage, (2) from the stores to the shops, (3) from one machine to another, (4) from one department to another, belongs to one and the same class of activity. In all well arranged factories such movements are at a minimum. Where the cost of such movements is high it represents in most cases reducible inefficiency. Most certainly it forms in accordance with our definition of indirect expense, *a particular class of service,* rendered to production. That being the case it is obviously capable of being expressed as a factor of production, high or low according to relative efficiency. Further, whether raw or partly finished materials are kept in stores in charge of a store-keeper, in the shops in charge of a foreman, or in an assembling room in charge of a production clerk, such storage merely represents the halting places in a general process of movement. The whole process is that of the *circulation of materials,* which necessarily involves both movement and rest—which in fact starts from rest (in the stores) and returns to rest (either in the stores again, as in the case of finished

parts), or in the warehouse as saleable stock. Stores and transport are therefore different aspects of one and the same service to production, and we have now to consider what are the elements of expense pertaining to such service, and how they can be reduced to such a basis as will enable them to be expressed as a factor of production-centre machine rates.

A preliminary examination will show the principal elements to be:—

1. Materials in Stores.	2. Materials in Movement.
Buildings, lighting, and heating factors.	Interest, depreciation and maintenance of:— cranes and hoists, transporters and runways, lifting blocks and tackle.
Interest, depreciation, and maintenance of stores fittings.	
Wages of storekeepers and assistants.	Wages of cranemen and labourers.
Carriage inwards on materials.	Power factor.
Interest on current balance of stores.	
Total annual expense of stores.	Total annual expense of transport.

Total Annual Expense of Stores-Transport.

These totals, however interesting, do not bring us any nearer to finding a basis of assessment. The principle being laid down throughout these articles is that the proper place for the transference of the incidence of burden to work *is the point of the tool,* it therefore follows that this basis of assessment will be of a different nature from any we have yet considered.

Looking at the question broadly we shall perceive that this class of expenditure has relation to bulk and weight rather than to value. The storage and handling of a gun-metal casting costs no more than that of one of the commonest and cheapest iron. A partly finished cylinder costs no more to handle than the original rough casting. It is therefore weight and bulk rather than value that must be taken as a guiding principle in our search for a basis of assessment. A little consideration will show that the movements of a large casting have a very close relation to the working of production centres, such as machine-tools. Castings or any kind of materials are not moved about for amusement. Every movement has some relation to work either just done or about to be done. It will therefore also bear some relation to the nature and importance of the tool. Again, a large overhead traveller is not put in motion in order to supply metal rods to a group of screw machines, neither is the cost of a continuous band

conveyer receiving the product of such machines in any way related to the work of heavy planing and milling machines because these latter may happen to be located in the same shop. The solution of a basis for assessment of a stores-transport factor is outlined by these considerations, and is shown to have certain natural lines of development. The principle not of "analysing" but of "keeping separate" shows the course to be adopted.

It may be said at once that there is no magic formula, no convenient multiplier or percentage, that will solve such a problem offhand. One "simple" method will of course suggest itself to those to whom simplicity is an end in itself, *viz.*, the expression of cost and storage as a percentage of the value of stores issued. But not only has it been shown that bulk and weight rather than value are the real bases of connection, but there is also the very important consideration that transport is more or less a continuous or repeated operation, and the ultimate cost of transport for a heavy piece of work depends not only on the initial weight or cost of the casting, but still more on the number of times that it has been necessary to handle it. Further, the large casting rarely passes through the stores at all. It goes direct from the foundry or the works gate to the place where the first operation is to be performed on it. It has also been shown that certain kinds of transport are confined to the products of particular classes of machines. Such an invitingly "simple" method, therefore, takes no account of the very features that it is necessary to emphasise if the resulting factor is to be any guide to realised or unrealised efficiency. It would merely produce a figure of no utility whatever as a guide to such condition of efficiency.

It may also be said at once that the determination of this factor is a troublesome though not necessarily a difficult undertaking. It requires a broad and competent survey of every detail of the movements of stores and materials. It is one of the good points of the production-factor method that it does press such reviews of different services not merely on the attention of the accountant, but also on the attention of some technically qualified person. The stores-transport factor can only be determined by first assembling all the elements of that class of expense, and then carefully tracing out their connection with production centres. These elements divide themselves into general and special—the former, represented by the cost of stores keeping and of any mechanism of transport such as a runway that cannot be connected with the products of any particular

group of tools, and the latter by the transport facilities that are localised and serve particular groups of production centres.

The allocation of general stores-keeping expense is first made by departments, and the basis of such distribution is a careful estimate of the relative call of each department on it. This will depend on the average volume of transactions, such as the number and weight of articles handled, and the whole circumstances of the business done. A very close approximation to facts can be made if this mapping out of the relative share of each department is done carefully and attentively. It will be obvious that sub-stores, assembling-rooms, and similar items already connected with the work of particular departments will not be thrown into the common charge for stores-keeping and then served out again. Such items will be kept localised from the beginning. Only absolutely common services must be included in the allocation to departments.

Particularised items, as already defined, will be kept separate until the time comes to connect them with machine rates as will be discussed in the next article.

The result of this preliminary mapping out of the field of stores-transport will be that each department will have:—(1) a share of the general stores-keeping expense proportional to the bulk of its transactions; (2) a number of particularised stores-keeping and transport charges already seen to be connected with groups or kinds of production centres. With this degree of localisation we must leave the question at present. The principle on which these still floating charges are fixed and made factors of machines rates must be left to the next article. It may however be mentioned that the same process of careful determination of relative use of these services is employed for fixing the amount to be borne by different machines. The provision for checking actual and estimated performance must also be left to the same occasion.

The Organisation Factor.

The last of the important indirect services to production, (with the exception of management and supervision) is that which comprises the working of cost systems, time-keeping, and methods of tracing and regulating the progress of work through the shops, including the routine of orders, and purchasing, but not selling. Such expenditure forms a clearly defined and easily isolated group, although in a few cases care must be taken with regard to the wages and salaries of men with multiple duties. In view of the great de-

velopment that has taken place of recent years in methods of organisation, comparative figures with regard to the costs of organisation would possess the greatest interest, and very wide variations of value and efficiency would be revealed if they were made generally available by publication of standardised figures. In the absence of such data or of any basis for comparison, a great deal of wasted expenditure is certainly going undetected.

The elements of the organisation factor may be summarised as follows:

1. Buildings factor of special offices.
2. Wages of timekeepers, cost clerks, and order clerks.
3. Expenditure on forms, books and cards.
4. Percentage of expenses in accounting department representing time given to works costs and purchasing.
5. Wages of watchmen.
6. Interest, depreciation and maintenance of special appliances, furniture, calculating machines, typewriters, etc.

The annual expenditure on these and similar items being collocated and verified, it remains to decide on a basis of assessment. Such a basis is most usefully and accurately found in a division by the total number of production centres throughout the works. The whole object of organisation being to marshal work systematically so that it may undergo operations with the least delay, and to record the cost of such operations correctly, it follows that this class of expenditure has a very definite relation to the activity of production centres. The only question is whether there is any greater call exercised by any particular class of machine than by any other class. A careful survey will show that this suggestion is untenable. The larger class of machines, for example, make no clearly defined demand for a larger share of organisation work than the small. Cost work has a much closer relation to the number of machines than to their size or value. Substantial justice will therefore be done if we regard each production centre as having an equal share of the cost of organisation. It will be noticed that this division is also practcially equivalent to an equal distribution per head of the productive staff. The division by the number of production centres provides, of course, a figure ready to hand for inclusion as a factor of machine rates.

Management and Supervision.

In dealing with management and supervision we pass again into a field requiring somewhat careful survey. The elements of the factor are:—

1. Works manager's salary.
2. Wages of foremen.
3. Wages of leading hands not capable of direct charging.
4. Cost of inspection.
5. Buildings factor of special offices.
6. Interest and depreciation and maintenance of furniture, fixtures, etc., used in this department of work.

Following the lines of keeping all expenditures localised as far as possible, we see that the cost of inspection is closely related to the machines of which the products are inspected, (inspection by a special official is of course meant, not simple "passing" by a foreman). The supervision of leading hands is similarly localised. The wages of foremen are localised to a less extent, viz., by departments. The expenses of management alone are absolutely general.

Here again, no golden rule for a simple assessment is possible. We must begin by taking the localised expenses, observe how they are related to each production centre that they serve, and divide them up accordingly. In the same manner we deal with the less generalised expenses, in larger groups, until all are exhausted. The absolutely general expenses of management are first allocated to departments by a careful study of the relative demand of such departments on the time and resources of the management. Some departments will be found to take a large percentage, others will obviously take very little, depending upon the complexity of the work carried on. The element of judgment that enters into this factor will make it none the less accurate if the circumstances are thoroughly gone into.

Having thus dealt with the principal factors of manufacturing production, we shall give attention in the next article to a demonstration of the precise means whereby these factors are connected with particular production centres and so become machine-rate factors.

ENGINEERING ASPECTS OF LARGE ELECTRIC POWER CONTRACTS.

By Howard S. Knowlton.

Mr. Knowlton presents here the second of two articles discussing the relations between the power company and the power consumer in a new manner and from a new point of view. The purpose is to treat the manufacture and sale of power according to the principles that have been established in the construction and manufacture of engineering products generally. The proposition is analyzed into its elements and sub-divided into its details, each feature being clearly defined and rules given for its successful management. This paper concludes the discussion.—THE EDITORS.

IN the first part of this article an attempt was made to show the increasing need of dealing with electric power supply on a large scale from a broad engineering and commercial point of view, and to emphasize the fact that standards of practice acceptable in the old days of local sales by central stations, occupying restricted fields and serving limited populations, no longer apply to the distribution of power over wide areas. Passing from the features of investigation, design and construction to the problems connected with the preparation of large power contracts, an effort was made to present in a logical form the more important engineering considerations bearing upon such agreements, to the end that a basis of action might be available for those facing the purchase of large power and for companies establishing methods of selling energy on an extensive scale. Under the subdivisions "Definition of Service" and "Payment for Service" were considered the more important matters that the engineer should place in the hands of the legal advisers of his client for suitable shaping in terminology. In the present and concluding section, the questions of "Establishment of Service," "Operation of Service," and "General Considerations" will be reviewed.

3.—ESTABLISHMENT OF SERVICE.

a. Physical limits of responsibility.

Too much care cannot be taken in a power contract to define the limits of physical responsibility of each party, and to avoid omitting any parts of the system through inadequate appreciation of the plant necessary to handle the proposed service. It may not require much space to handle this aspect of the agreement, but it is important to

state just where the duties of each company or party begin and where one or the other is expected to install equipment. If the purchaser is to own his sub-station building and equipment, the fact should be clearly set forth; if the power company is to supply energy through its own equipment as far as the low-tension bus-bars of the sub-station, and to furnish all equipment up to that point, the fact should be stated. Much will depend upon the local conditions, including the facilities of the purchaser or recipient for handling high-tension power, the previous ownership and operation of apparatus and buildings, anticipated changes in the local situation as a result of the entrance of new power into the field, the character of business of the purchaser, and other similar points. General good practice favors the installation and ownership of all very high-tension appurtenances by the transmission company, up to the point where the purchaser receives the service.

b. Franchises, rights of way, permits, taxable property.

If it becomes necessary to secure permits to open the streets, to erect certain lines or other structures in the municipality occupied by the recipient of power, to acquire franchises for local operation, and to purchase real estate, it is clearly desirable to include provision in the contract to apportion equitably the responsibility and cost of such work. If any special investment in equipment is needed on account of the advent of the new power into a hitherto unutilized field, due consideration must be given to the forthcoming taxation of such property, and the ownership and responsibility therefor plainly set down. In many cases nothing in the way of franchises or permits will have to be secured, but where the customer is a central station or an electric railway, and when a new distribution service of improved construction is necessary within the local field, it may be necessary to obtain permits for this new class of work before the power supply can be delivered. In a recent important agreement, the provision is inserted that the local central station shall at its own expense procure locations for distributing energy at the reduced voltage from the sub-station of the power company to such customers in the city as the power company may procure. The location secured is in each case subject to the approval of the power company. In the instance cited the local plant handles the service of the power company, although the latter deals with its own customers. A price of 1/20 cent per kilowatt hour transmitted over the local distribution system is to be paid the central station by the power company for the service ren-

dered. Duplication of distribution systems serving essentially the same character of business should be avoided as far as possible, and the foregoing illustrates how varied may be the conditions under which those selling power may labor, and still maintain friendly relations with organizations which are to some degree competitive.

c. Design and construction for transmission and distribution, permanent and temporary.

Approval of design and construction work by the power company may sometimes be required to protect the high-tension system from undesirable work on the premises of the consumer. While in most cases the protective equipment installed should prevent trouble on the high-tension system on account of defects or failures on the purchaser's system, it may be expedient to establish a certain standard of construction for the insuring of more reliable service, just as the central station in the smaller field frequently approves apparatus as a condition for the supply of power from its circuits. It is only just to the power company to allow it a certain share in the selection of equipment which exerts a direct influence upon the quality of its service, even though there may be no direct electrical connection between the machinery of the power company and the purchaser's equipment. In cases where temporary lines or equipment have to be installed to supply the consumer, supervision of the character of their construction and the responsibility for their cost are profitable matters for inclusion in the contract. Where an auxiliary plant is to be utilized for a portion of the service, the power company should reasonably be entitled to the privilege of passing upon the general fitness of such apparatus for co-operative working. In general it is well to define the meaning of the construction for which either company or party is to be responsible, in order to leave the future clear of undesirable entanglements. Usually the cost of construction mentioned is understood to mean the cost of original work only. In a representative case the power company is to provide all transformers, switches, lightning arresters, and other high-tension equipment located on the premises of its customers, and is to be wholly responsible for the erection, maintenance, and operation of its transmission line and substation.

d. Allowance for existing and future facilities (utilized under c).

In some cases the distribution of the transformed high-tension power does not require entirely new construction in the purchaser's territory, and an allowance may properly be made for the cost of

such established equipment as can be utilized. Thus, a portion of a pole line or a part of an underground conduit may be utilized by a city or central station buying power on a large scale from a transmission company, or again, in the future underground construction may be required by legislation, and the cost of such work or the avoidance of new construction on an independent route by the transmission company may properly be taken into account in making up the charges for service.

e. Apportionment of cost and approval of changes in service and equipment.

A clear assignment of responsibility for reconstruction work by the selling company and the purchaser in connection with the establishment of energy delivery need not be dwelt upon here, for its importance in a well-balanced contract is apparent on slight consideration. From time to time, however, changes become necessary in systems of distribution or their apparatus, and a wisely drawn contract will provide for the assignment of costs of such work in a general clause which will fit anticipated conditions on any part of the electrical system from the power house of the transmission company to the working apparatus of the consumer. For example, changes in the transmission service may require the relocation of a sub-station owned by the power company and the building of a new line for local distribution in the territory of the receiver. If the transmission company makes the initial move on account of conditions within its own special field of broad supply, the payment for such a relocation and reconstruction, with the establishment of new lines of distributing service should properly be borne by the power company. On the other hand, the securing of new customers by a central station buying power from a transmission organization or the establishment of a new motor-driven shop by an industrial plant using hydro-electric energy, should not entail financial burdens upon the transmission company for the alterations in the distribution system which may thereby be made necessary.

4.—Operation of Service.

a. Maintenance of equipment, repairs and depreciation.

Of equal importance with a provision setting forth the ownership responsibilities in power supply on a large scale is a statement of the parties who are to maintain the apparatus used. This is not a complex matter as a rule, although in some cases a divided ownership

in a sub-station may bring about some curious physical separations in maintenance responsibility, perhaps on the shaft midway between a synchronous motor and a direct-connected generator, or at the terminals of a certain line of oil switches on the rear of a switchboard panel instailation. If the care of the equipment is to be divided between the purchaser and the power company too much emphasis cannot be laid upon the importance of making the limits of each work clear. In most cases the high-tension apparatus is maintained by its owner, and the low-tension equipment may or may not be kept in condition by the purchaser. A recent electric-railway contract with a large power company provides that the maintenance of the sub-station apparatus belonging to the purchaser as well as that owned by the power orgnization is to be taken care of by the transmission company, except that no allowance for depreciation is to be made by the power company on the railway company's apparatus, and it is not to be held responsible for extraordinary defects arising from the railway company's neglect or improper use of its equipment. It seems only fair that the cost of depreciation in practically all cases should be sustained by the owner of the apparatus.

b. Labor requirements.

This point is too plainly essential to a good contract for power supply on a large scale to need special emphasis. No sub-station with valuable moving machinery may safely be left to its own devices in operation, and a provision for the handling of the equipment in routine and emergency service is clearly a vital point. In some cases it may be well to include the right of the power company to assume temporary operating possession of a sub-station owned and operated by a purchaser, in the event of an emergency situation on a great system; but in such an instance, the point should be made that the service of the power company to the purchaser shall suffer as little as possible by such handling. Where auxiliary plants are available at the sub-station sites, as in the cases of certain factories receiving power from a hydro-electric system and retaining part or all of their steam equipment for use in emergencies, the contract should state the labor responsibility in case the auxiliary equipment is operated, and if the factory staff are expected to run the power-supplying equipment when the auxiliary apparatus is shut down, the agreement should provide for this. In the railway contract suggested above the power company provides the attendance in the sub-station owned by the traction system. This is advantageous to the latter, since its em-

ployees are not concerned with the operation of the high-tension system in any way, and the railway service is handled in the same simple manner that would apply if the trolley lines had their own direct-current power station. It is not always realized by street-railway purchasers of very high-tension power what a difference there is between the handling of this class of energy and the operation of the system on the old and relatively safe 500-volt basis. It tends to simplify matters greatly when the power company assumes the entire operating burden of the alternating-current side of the system, regardless of the ownership of the equipment. Aside from the advantages this course affords the railway company, the power company finds itself better qualified to meet unusual situations when all the apparatus that is peculiarly its province is assigned to its continual jurisdiction.

c. Supplies.

In some cases an operating agreement is understood to embrace the supply of carbon brushes, waste, water, fuel, movable contacts, oil, and other minor supplies necessary in the maintenance of service, but for the sake of definiteness it is desirable to state in a large power contract who shall supply different parts of the system with necessities of the class indicated above. If an insulator fails on the distribution system inside the purchaser's territory, for example, a proper assignment of the charge should be covered by the general terms of the supply clause in the contract. Of course, if the contract contains no provision for the purchase of supplies by the power company in case they become needed on the purchaser's property, the former cannot very well be forced to pay for such material, but a clear statement of the responsibility beforehand will eliminate the danger of disagreements.

d. Accidents and emergencies.

The amount of money involved in the settlement of damages in case of accidents is often so great that a careful treatment of this topic in a contract for the sale of power is imperative. It is questionable how far it is necessary to go in pre-defining responsibility in specific cases that may arise in practice, but in general a blanket clause sharply limiting the liability of each party to its own system works out well in the long run. Exceptional cases occur in which the failure of apparatus on one side of the system causes a progressive wave of destruction to pass through the system of the purchaser, and in other instances a fault on the purchaser's lines produces trouble

miles away on the transmission network. Where distant troubles are clearly due to local defects, it is reasonable to divide the damages on some equitable basis, but there should be no question as to the cause of the difficulty if settlements are to be made by either party outside its own territory. In emergencies the greatest latitude should be permitted, and the closest co-operation afforded on each side to establish the service on a firm basis. The average contract may not provide for telephone service between the operating centres of the power company and the purchaser's points of utilization or reception, but experience shows that money expended in this direction is well invested. Where a central station serves customers with power derived from a large outside organization, it is sometimes desirable to omit any responsibility for interruptions in the agreements between the central station and its patrons, except in so far as those cessations of service may be due to failures of equipment in the steam or other generating plant of the central station itself.

e. Auxiliary supplies of service, co-operation, reciprocal contracts.

In many hydro-electric power systems the water supply is of such variable character throughout certain portions of the year that electricity must be generated from steam- or gas-engine-driven generators. The cost of maintaining and operating auxiliary capacity is always more or less of a burden upon a hydro-electric system, and in recent practice a plan has been brought forward by which the generating capacity of industrial and other plants formerly producing their own energy is retained for emergency service on their original sites. This cuts down the necessary investment of the power company in auxiliary capacity, and sometimes eliminates it altogether. Local conditions produce wide variations in agreements for the use of so-called reciprocal power; but in general, clauses dealing with this method of preserving the service provide that on suitable notice, generally 24 hours, the large purchaser agrees to start up his own plant and feed power in the reverse direction into the system of the transmission company within the rating of his installation capacity. The saving in fixed charges is very attractive in most instances. The paragraphs in a power contract which deal with reciprocal relations should properly discuss the rates allowed, with deductions, if any, for the use of the purchaser's auxiliary service, operating responsibilities, assignment of repairs to auxiliary apparatus, furnishing of supplies, liability for accidents in the auxiliary stations, and in a brief manner all the most important features of a power contract on the usual basis, omitting, however, any complications which can be cov-

ered by a blanket clause. In some instances it will prove desirable to make an independent contract for reciprocal power, for the conditions vary through a much wider range than in the supply of energy to a purchaser from a single central system.

5.—General Considerations

a. Termination of agreement.

There is little of engineering interest under this heading, except a possible alteration of rates as the life of a contract diminishes. The possible terms under which operation may be required at the expiration of a power agreement should be briefly considered before the life of the agreement is established, for in most cases the power company looks forward to a renewal of relations.

b. Renewal of agreement.

A provision for the renewal of the contract at the expiration of a certain term is sometimes expedient, in lieu of a long-time agreement. Here the important point usually for the power company, and no less for the purchaser, is to avoid committing itself to any iron-clad, inflexible renewal without the opportunity to review the situation and if desirable, make such modifications as may be mutually agreed upon. A certain schedule of rates may be offered by a company after five or ten years, for example, but nothing in the clause stating this should prevent the establishment of an entirely new contract, if conditions require it. It cannot be too strongly emphasized that the costs of generating, transmitting, and distributing electrical energy on a large scale may undergo broad modifications in even a few years on account of changes in the art and alterations of the local conditions. When a provision for a renewal is incorporated, therefore, it should not be too inclusive. A mutually profitable relation is the desirable state of affairs.

c. Competition.

Under this heading it may sometimes be desirable to permit the purchaser to buy power from other sources without prejudice to his service and relations with the transmission company, or, as in the Fitchburg case, cited before, permission may be granted the central-station customer to buy power from the local company in more or less active competition with the transmission service. Of course, it may be urged that the transmission company has no right to interfere with any power arrangements its customer may desire to make with

cther parties, and it is clear that no right exists outside a direct provision of the sort in a contract or franchise. The point is worth considering, however, in reaching a basis for an agreement, and if it is for the best interests of the power company to confine the purchases of a certain customer to its service, it may be worth while to make a strong effort to incorporate such a clause in the contract.

d. Modifications or review of the agreement after stated terms.

In cases where a doubt exists as to the ultimate profitableness of an important power contract after experience, or if a loop-hole of escape from future unsatisfactory conditions is desired, a clause may be incorporated providing for a review of the agreement after a stated time by a competent agreed-upon authority. In the Fitchburg agreement mentioned the Massachusetts Gas and Electric Light Commission may review its terms after ten and twenty years upon request of the municipal authorities, and if it finds modification to be in the public interest, it may order such changes of a reasonable character as it deems necessary. Acceptance of such recommendations is not necessary by the parties to the agreement unless they desire to continue it—in other words, it becomes null and void if either the Connecticut River Transmission Company or the Fitchburg Gas and Electrc Light Company does not desire to meet the modifications ordered by the Board.

e. Arbitration.

In the making up of a technical agreement like a power contract, a final and most valuable provision may be for the arbitration of any disputes which may arise under it between the signatory parties. The selection of the arbitration board in such cases should not be left to chance, as expert ability is always needed to reach fair judgments in such technical disputes. A commonly acceptable plan is for each party to select an arbitrator, and the two to choose a third. In other cases the then occupants of certain responsible engineering, executive or legal positions may be designated, with satisfactory results.

EDITORIAL COMMENT

Profitable Forestry.

THE cause of conservation has made important progress in the United States in recent years, especially, perhaps, in an increased appreciation of the need for better forestry laws and methods. Here, indeed, the destructive waste of the old order is most apparent, not only in its immediate effect upon timber resources, but in the scarcely less disastrous part it plays toward the great potential developments of hydraulic and electrical engineering and of the mechanical industries dependent on them.

Progress toward betterment, however, is trifling compared to that which would be made if forest cultivation were shown and believed to be profitable. It may be of value, therefore, to note some results secured on the timber lands of Switzerland and reported in a recent bulletin issued by the Forest Service of the U. S. Department of Agriculture. The law provides that the output of timber shall not be permitted to exceed the natural growth and that protected forests (which comprise most of the timber land of the country) shall not be diminished in area and shall be kept fairly dense.

Statistics of revenue derived wholly from timber output (there being no manufacture of rosin, turpentine or similar by-products) show that in 1898 2,400 acres of land in the canton of St. Gall yielded a clear profit of $17,350, and 2,800 acres in the town of Winterthur gave a clear profit of $29,500. These annual revenues per acre are larger than the total value per acre of unintelligently handled forest lands in New York State. There is a suggestion here of profits that might tempt even an investor in mining stocks.

Training for Industrial Executives.

IN a leading article in this issue, Mr. Trask discusses a serious problem of modern industry—the "minor executive"—and seeks solution in larger recognition of and dependence upon the technical graduate. Here is a matter in which the technical schools may fulfil a mission, perhaps the most important now open to them, by providing training more closely adapted than any they now offer to the prospective industrial executive.

It is interesting to note that educational courses in electrical engineering, like those in the mechanical department, have now begun to feel the same demand. Parallel with specialization in one direction toward pure science, there is the commencement of specialization in another direction toward the applications of electricity to manufacturing and public utilities. Thus, in a recent bulletin from the Electrical Engineering Department of the Massachusetts Institute of Technology, the announcement of continuance of advanced instruction in the theory of the alternating current and in investigation and research connected with the electrical transmission of power, is followed directly by the mention of courses on the organization and administration of public-service corporations and on the designing of electric plants.

In the electrical industries as well as in manufacturing the demand for scientifically trained plant managers acquainted with the economic, sociological, and commercial aspects, as well as the purely technical elements, of the mixed problem of production, is certain to increase and likely to absorb the major fraction of the total number of graduates. Efficient methods for education in scientific works-management and administration must receive more attention from our technical schools than has yet been granted. Only here and there as yet is the full import of the matter even conceived of, and nowhere as yet is it given anything like adequate recognition by concrete provisions in the curriculum.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

GASOLINE AND ALCOHOL AS MOTOR FUELS.

COMMERCIAL DEDUCTIONS FROM COMPARISONS OF GASOLINE AND ALCOHOL TESTS ON INTERNAL-COMBUSTION ENGINES.

Robert M. Strong—Bulletin of the United States Geological Survey.

A PRELIMINARY report on a series of over two thousand comparative tests of gasoline and alcohol as fuels for combustion motors, concluded early in 1908 by the Technologic Branch of the United States Geological Survey, was reviewed in these columns in THE ENGINEERING MAGAZINE for May, 1908. The data then published referred principally to the comparative fuel consumption of gasoline and alcohol engines working under the same conditions. The final report on the tests has now appeared as Bulletin 392 of the Geological Survey publications, under the title: "Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines." We supplement the information we have already given by the following summary of the more important results and conclusions stated in the bulletin.

The low heating value of completely denatured alcohol will average 10,500 British thermal units per pound, or 71,900 British thermal units per gallon. The low heating value of 0.71 to 0.73 specific gravity gasoline will average 19,200 British thermal units per pound, or 115,800 British thermal units per gallon. The low heating value of a pound of alcohol is approximately six-tenths of the low heating value of a pound of gasoline. A pound of gasoline requires approximately twice the weight of air for complete combustion as a pound of alcohol. The heating values of explosive mixtures of alcohol vapor and air and of gasoline vapor and air, each having theoretically just enough air for complete combustion, are approximately equal—about 80 British thermal units per cubic foot.

Explosive mixtures of alcohol vapor and air will stand much higher pressures without preignition than explosive mixtures of gasoline vapor and air. The maximum compression pressure which can be used without danger of preignition will depend in each case on the quality of the mixture, the design of the engine, and the speed at which it is operated. For 10 to 15 horse power four-cycle stationary engines of the usual type, the maximum pressure which can be used safely is about 70 pounds per square inch above atmospheric with gasoline mixtures, and about 180 pounds with alcohol mixtures. From the standpoint of fuel economy, the most advantageous compression pressure is the highest that can be used without causing preignition.

In general, the alcohol engine is, or can be, so designed and constructed as to be fully the equal of the gasoline engine in adaptability to service. A gasoline engine having a compression pressure of 70 pounds but otherwise as well suited to the economical use of denatured alcohol as gasoline will, when using alcohol, have an available horse power about 10 per cent greater than when using gasoline. When the fuels for which they are designed are used to an equal

advantage, the maximum available horse power of an alcohol engine having a compression pressure of 180 pounds is about 30 per cent greater than that of a gasoline engine having a compression pressure of 70 pounds, but of the same size in respect to cylinder diameter, stroke and speed. Explosion pressures in 10 to 15 horse power four-cycle stationary alcohol engines compressing to 180 pounds and working at maximum load reach 600 to 700 pounds per square inch. Stationary gasoline engines, in which the compression pressure can be raised in some cases to 180 pounds, are not usually built heavy enough to stand such pressures for any length of time.

A gasoline engine with compression pressure suited to gasoline mixtures will in general consume 50 per cent more denatured alcohol than gasoline per brake horse power per hour. The volumes of fuel consumed by alcohol and gasoline engines with compression pressures suited to the fuel used will in general be the same per brake horse power per hour. At rated load and with reasonably favorable adjustment of mixture quality and time of ignition, gasoline engines of the usual four-cycle stationary type will consume about a pint of gasoline per brake horse power per hour. At light load and at maximum load, gasoline and alcohol engines governed for constant speed require more fuel per brake horse power per hour than at rated load, when the latter is about 75 to 80 per cent of the maximum load; but unless the mixture quality and time of ignition are adjusted to suit each change of load, the rate of consumption per brake horse power per hour will in general be least at maximum load and will increase with decrease of load. With any of the usual methods of governing, the fuel consumption of alcohol and gasoline engines will ordinarily be about twice as great at one-third as at maximum load. At the same time an excessive rate of consumption at any given load, if due to the incorrect adjustment of the mixture quality and time of ignition only, may be as great as, but not greater than, approximately twice the minimum required before it will be noticeable from outward indications.

The thermal efficiency of alcohol and gasoline engines will in general increase with the pressure to which the charge is compressed when ignited. A high thermal efficiency and a rate of consumption of less than a pint per brake horse power per hour, both for gasoline and for denatured alcohol, can often be obtained when the degree of compression, the load, the quality of the explosive mixture and the time of ignition are carefully adjusted.

When gasoline and alcohol are used simultaneously in varying proportions from practically all gasoline to practically all alcohol, the most advantageous degree of compression will vary from that found to be the best for gasoline mixtures to that found to be the best for alcohol mixtures. The total amount of fuel consumed per unit of power, however, is practically constant for the entire range of proportions from all gasoline to all denatured alcohol.

When introduced at the most advantageous location, water may be sprayed into an explosive mixture of gasoline vapor and air as it is being taken into the cylinder of an engine, in amounts up to as much water as gasoline by weight without affecting the performance of the engine. The maximum available horse power, however, decreases with increase in the percentage of water by weight in the mixture. In an engine having a constant degree of compression, the presence of water in the explosive mixture to an amount equal to or less than the weight of gasoline does not affect the amount of gasoline required to carry any given percentage of the corresponding maximum available load, but the compression pressure possible without preignition increases with increase in the percentage of water in the mixture. When the weights of water and gasoline are equal, the compression pressure can be raised to about 140 pounds.

Alcohol diluted with water in any proportion from denatured alcohol, which contains about 10 per cent of water, to mixtures containing about as much water as denatured alcohol can be used in properly equipped and adjusted gasoline and alcohol engines. In an engine having a

constant degree of compression, the amount of pure alcohol required for any given load increases and the maximum available horse power of the engine decreases with a diminution in the percentage of pure alcohol in the diluted alcohol supplied. The rate of increase and decrease is such, however, that the use of 80 per cent alcohol instead of 90 per cent, or denatured alcohol, has little effect on the performance of the engine. As in the case of gasoline, the compression pressure possible without preignition increases with an increase in the percentage of water by weight in the mixture.

The relative hazard involved in the storage and handling of gasoline and denatured alcohol is of particular importance in considering their use as fuels in places where a general fire would be likely to result from the accidental burning of the fuel stored or carried for immediate supply. It is indicated by statistics, and is also the general consensus of opinion of those experienced in handling gasoline, kerosene, and alcohol, that the hazard involved in the use of denatured alcohol is very much less than in the use of gasoline and possibly less than in the use of kerosene, but as yet the relative fire risk has not been determined.

In regard to general cleanliness, such as absence of smoke and disagreeable odors, alcohol has many advantages over gasoline or kerosene. The exhaust from an alcohol engine is never clouded with a black or grayish smoke, as is the exhaust of a gasoline or kerosene engine when the combustion of the fuel is incomplete, and it is seldom, if ever, clouded with a bluish smoke when a cylinder oil of too low a fire test is used or an excessive amount supplied, as is so often the case with a gasoline engine. The odors of denatured alcohol and the exhaust gases from an alcohol engine are also not likely to be as obnoxious as the odor of gasoline and its products of combustion.

Very few alcohol engines are being used in the United States at the present time, and but little has been done toward making them as adaptable as gasoline engines to the requirements of the various classes of service. Engines for stationary, marine and traction service, automobiles, motor trucks, and motor railway cars designed especially to use denatured alcohol have, however, been tried with considerable success.

The price of denatured alcohol is greater than the price of gasoline, and the quantity of denatured alcohol consumed by an alcohol engine as ordinarily constructed and operated is in general relatively greater than the quantity of gasoline consumed by a gasoline engine of the same type. Considerable attention is being given to the development of processes for the manufacture of alcohol from cheap raw materials which are generally available, and it seems reasonable to expect that the price of denatured alcohol will eventually become as low as, or lower than, the price of gasoline, especially if the price of gasoline advances. It also seems reasonable to expect a greater general improvement in alcohol engines than in gasoline engines.

Although denatured alcohol, when used as a fuel, is not always so classed as to be exempt from restrictions, the restrictions placed on its use are never greater than those placed on the use of gasoline. When the restrictions are less than those placed on the use of gasoline, or where safety and cleanliness are important requisites, the advantages to be gained by the use of alcohol engines in place of gasoline engines may be such as to overbalance a considerable increase in the fuel expense, especially if the cost of fuel is but a small portion of the total expense involved. Denatured alcohol, however, will probably not be used for power purposes to any great extent until its price and the price of gasoline become equal and the equality of gasoline and alcohol engines in respect to adaptability to service required and quantity of fuel consumed per brake horse power, which has been demonstrated to be possible, becomes more generally realized. A further general development in the design and construction of engines that use kerosene, or cheaper distillates, and the crude petroleums may be reasonably expected and may delay the extensive use of denatured alcohol for some time to come.

ELECTRIC ZINC SMELTING.

A DESCRIPTION OF THE CÔTE-PIERRON ELECTRIC FURNACE AND PROCESS FOR THE DIRECT REDUCTION OF ZINC ORES.

Electrochemical and Metallurgical Industry.

AFTER an article by Eugène Fleurville in *La Houille Blanche, Electrochemical and Metallurgical Industry* for November, 1909, publishes a description of a new electrical process of zinc smelting, invented in 1906 by two French metallurgists, Côte and Pierron, and applied on a commercial scale at a plant in the Pyrenees since May, 1907. The process, which involves certain novel chemical reactions, successfully reduces zinc blende, effects complete separation between lead and zinc in complex ores, and produces either pure metallic zinc or commercial zinc white. The principal features of the design and operation of the furnace, the reactions involved, and some details of capacity and cost are given very briefly below.

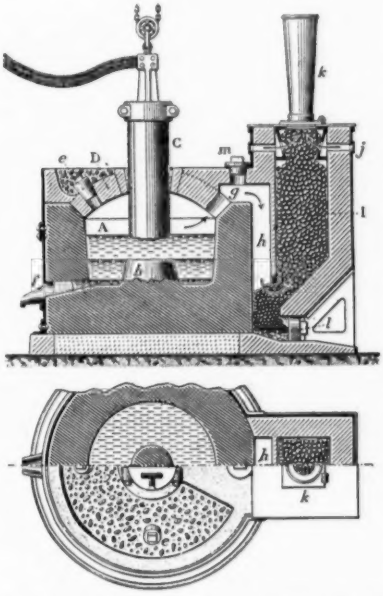
The retort furnace for zinc smelting utilizes only 10 to 12 per cent of the heat units set free by the combustion of the coal. In the closed electric furnace operated at a temperature of, at most, 1,800 degrees C., it is possible to utilize 45 to 50 per cent of the heat units produced from electrical energy. Hence, the expenditure of 1,000,000 calories in the electric furnace, corresponding to 95 to 100 electrical horse-power days, will do the same amount of work as a ton of coal liberating 6,500,000 calories. When the cost of 95 or 100 electrical horse-power days is no greater than that of a ton of coal, it is decidedly advantageous to use the electric process for the smelting of zinc ores. It is apparent that, taking into consideration the more common location of zinc deposits in mountainous districts and near sources of water power, the electric furnace is likely to be found more widely applicable in the metallurgy of zinc than to the reduction of iron ore.

Labor costs in the electrical process are undoubtedly lower than when retort furnaces are used. The main item of maintenance expense in the latter process, the renewal of the clay retorts, will be replaced in the electrical process by the cost of electrode renewal. It would seem, however, that the maintenance expense of the electrical process should be less than that of the retort process. The first cost will certainly be less. But it is especially in respect to the reduction of zinc losses that the electrical process possesses a real superiority over the methods now in use. In Belgian and Silesian practice, zinc losses due to incomplete extraction and the escape of the metallic vapors through the retort walls are below 10 per cent only in exceptional cases when working on 45 to 50 per cent ore, and rise to 20 per cent when the zinc content of the ore is 25 per cent. By the electrical process 30 per cent ore can be treated directly with a total loss of less than 7 per cent.

The two features of special interest in the Côte-Pierron process have to do with the reduction of the ore and the condensation of the zinc vapor. In order to facilitate the regulation of the temperature in the condenser independently of the furnace operation, a column of granulated carbon compressed between two electrodes in a vertical cylinder with refractory walls is employed for the purposes of condensation. The carbon is heated electrically by a current shunted off from the main supply. The temperature can be adjusted by varying the length of the column or the compression of the granulated carbon particles.

The chief difficulty in zinc condensation in the retort process, the large admixture of carbon monoxide in the metallic vapor, is avoided by the employment of a perfectly novel method of ore reduction. The zinc blende is allowed to react with iron in the fused bath. The iron combines with the sulphur, and the zinc vapors are set free, according to the formula $ZnS + Fe = Zn + FeS$. Even this method, however, does not yield pure zinc vapor. Steam from the moisture in the ore, carbonic acid from the carbonates in the gangue, and air introduced with the charge are

usually present, and react with the zinc vapor, which is easily oxidized, to form "zinc mist." "Zinc mist," while not so troublesome in condensation as carbon monoxide, has to be reduced in order to prevent the deposition of zinc dust in the condensers. Côte and Pierron first contemplated the melting of the iron and zinc ore in separate crucibles and their mixture in a third reaction crucible to which no gases would have access. Finally, however, the simpler method of reducing the "zinc mist" by passing it through incandescent carbon in the condenser was adopted.



VERTICAL AND HORIZONTAL SECTIONS OF THE CÔTE-PIERRON FURNACE AND CONDENSER.

A, the crucible, bottom and sides of graphite encased in sheet metal; *b*, a projection from the centre of the bottom of the crucible; C, the vertical electrode, the lower end of which is above the projection *b* (the walls of the furnace form the other electrode); D, roof of refractory material; *e*, charging holes, closed during operation by refractory stoppers; *f*, tapping hole; I, the condenser, a chamber with vertical refractory walls, filled with carbon particles heated to a cherry red; *g*, outlet for the zinc vapors, which reach the condenser through the long channel *h*; *l*, tapping hole of the condenser; *j*, opening for air admission; *k*, stack, for the regulation of the temperature of the carbon in the upper part of the condenser; *m*, an opening provided for cleaning the channels *g* and *h*.

The process is well adapted to the treatment of complex zinc-lead ores; a practically complete separation of the two metals is obtained. The crushed ore mixed with finely divided iron and a suitable flux is heated in the furnace by the walls, which are kept red hot by a special device. The lead is precipitated and removed from the furnace. The charge is then heated by the electric current and the zinc vapor set free by the action of the iron passes over to the condenser practically free from lead, the iron sulphide collecting on the bottom of the furnace under the fused slag. When the reaction between iron and ore has ceased, the furnace is heated to a high temperature for a short time to drive off any zinc remaining in the slag. The iron sulphide and the slag are then tapped from the furnace and a new charge is introduced.

The accompanying diagram shows transverse and vertical sections of the latest type of Côte-Pierron furnace and condenser. While one charge is being smelted, another is being dried on top of the furnace. When the furnace is tapped, the electrode is lowered and brought in contact with the projection *b*, the feeding holes are opened and the dried charge is introduced into the furnace. The feeding holes are then closed and a new charge placed on top of the furnace to dry.

The electrode remains in contact with the projection *b* while lead precipitates from the ore and is drawn off through the open tap hole *f*. Practically none of the current passes through the charge. During this time the door *l* of the condenser is left open and the pieces of carbon are allowed to slide down in the condenser, cleaning the condenser thoroughly, while the temperature reaches the upper limit of the range within which the zinc is condensed. The vapors set free from the fused bath of iron, silica and lime, passing through *h*, are arrested by the carbon in the lower part of *h*. They are automatically removed from the condenser whenever the door *l* is opened to tap the molten zinc and let the carbon pass down. It is, therefore, easy to remove any momentary clogging that may occur.

When all the lead has been precipitated, *f* and *l* are closed and the electrode raised, to heat the charge by resistance and arc heating. Iron sulphide forms and collects at the bottom of the furnace. No current passes through it; all the current passes between the electrode and the projection *b*. Finally, by simple arc heating, the zinc is set free and the slag is brought into a fluid condition convenient for tapping. At this moment the layer of slag between the electrode and the projection *b* receives practically the whole thermic effect of the current. As a result the volatilization of the iron is reduced, the crucible is better preserved, and the electro-thermic efficiency is raised.

Zinc vapor leaves the furnace at a temperature of 1,200 to 1,300 degrees C. In the lower part of the condenser the carbon is rapidiy brought to the temperature of the reduction of zinc oxide. Rising through the condenser, the zinc vapor gives up its heat to the carbon, but the carbon particles are sufficiently hot to prevent too rapid cooling of the zinc vapor. The zinc gradually condenses on the carbon particles and trickles down to the bottom of the condenser, whence it is drawn off through the door *l*. The carbon monoxide resulting from the reduction of the zinc mist escapes through the stack *k* with the gases of combustion of the pieces of carbon from the upper part of the condenser. The regulation of conditions requires skilled and attentive workmen, but the electric furnace is much more easily and quickly regulated than the retort furnace.

Extended experiments on a commercial scale have been made since May, 1907, at an abandoned carbide works at Arugy in the Pyrenees. Details of one of the most important of the trial runs are as follows:

Total time of the experiments, hours	240
Weight of ore smelted, kilograms	14,560
Average zinc content, per cent	43.6
Weight of iron mixed with ore, kilograms	6,235
Weight of fluxes charged, kilograms	3,480
Mean Current:	
Amperes	4,300
Voltage	40
Power factor	0.80
Weight of zinc oxide obtained, kilograms	6.730
Metallic zinc condensed before passage to the combustion apparatus, kilograms	182
Zinc content in slag and iron sulphide, per cent	2.7
Electrodes consumed, kilograms	193
Cost of electrical energy, francs per horse-power year	65

Electrodes cost 52 francs per 100 kilograms, iron 60 francs per ton, and lime 15 francs per 1,000 kilograms. The average wage paid the workmen was 3 francs per day. The total cost of producing the 6,912 kilograms of zinc oxide and metallic zinc was 2,396 francs; including the cost of packing and loading on cars, 2,631 francs. The oxide sold at 46.3 francs per 100 kilograms. The total income was 3,200 francs.

In the production of zinc white by the iron reduction process an objectionable amount of iron volatilizes and mixes with the zinc oxide fumes. To produce an absolutely pure zinc white from crude low-grade ore recourse has been had to another reaction: $ZnS + CaO + C = CO + CaS + Zn$. This lime-carbon process has been employed for the production of zinc white with entire success. In one test covering 600 hours and treating 76 tons of ore from which 13,193 kilograms of zinc white were theoretically obtainable, the actual recovery was 12,370 kilograms, at a cost of 4,598 francs. The product was sold for 6,102 francs.

THE CHARACTERISTICS OF MODERN ELECTRICAL MACHINERY.

A GRAPHICAL SUMMARY OF MODERN BRITISH PRACTICE IN THE DESIGN OF GENERATORS AND MOTORS.

L. Crouch—The Electrical Review.

THE curves reproduced on the following pages from an article by Mr. L. Crouch in *The Electrical Review* for October 22, 1909, present in very convenient form a large number of data of the weight, speed, cost, efficiency and power factor of direct- and alternating-current generators and motors typical of British practice in the design of dynamo-electric machinery. Mr. Crouch's descriptive commentary on the phenomena disclosed by the curves we are able to reproduce only in very brief abstract.

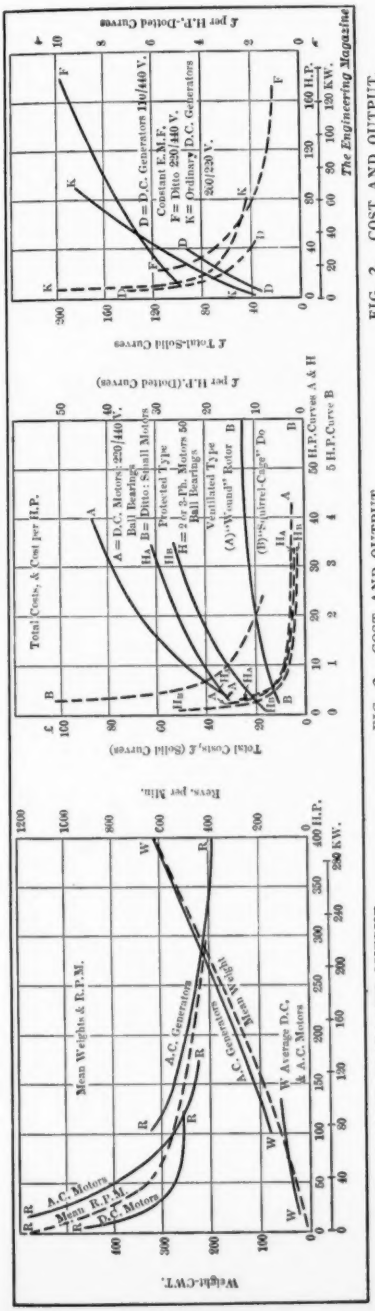


FIG. 1. WEIGHT, SPEED AND OUTPUT.

Total Costs, & Cost per H.P.
A = D.C. Motors 220/440 V. Ball Bearings
B = Ditto: Squirrel Motors
Protected Type
H = 2 or 3-Ph. Motors 50 Ball Bearings
Ventilated Type
(A) "Wound" Rotor B
(B) "Squirrel-Cage" Do
50 H.P. Curves A & H
5 H.P. Curve B
£ per H.P. (Dotted Curves)
Total Costs, £ (Solid Curves)
The Engineering Magazine

FIG. 2. COST AND OUTPUT.

D = D.C. Generators 110/440 V. Constant E.M.F.
F = Ditto 220/440 V.
K = Ordinary D.C. Generators 200/220 V.
£ per H.P.-Dotted Curves
£ Total-Solid Curves
H.P.
KW.
The Engineering Magazine

FIG. 3. COST AND OUTPUT.

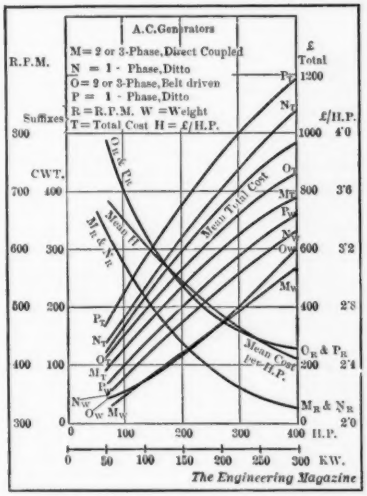


FIG. 4. SPEED, WEIGHT, COST AND OUTPUT.

In the earlier curves, several types of motors and generators are discriminated between. The later curves, however, give only mean representative values, the only distinction being between direct-current and alternating-current machines and between the full-load, three-quarter-load, and half-load efficiencies and power factors. Curves 1 to 7 divide machines into various classes, first, direct- and alternating-current machines, motors and generators, and further, ball-bearing machines, machines with ordinary bearings, and in the case of alternating-current motors, machines with "wound" and "squirrel-cage" rotors, respectively. All quantities are given in horse power but a kilowatt scale has been added to those curves dealing with generators.

The curves in Figure 1 exhibit no striking peculiarity. The difficulty of deducing a mean curve between revolutions and horse power is recognized by Mr. Crouch, who has attempted to represent in these curves only the revolutions per minute at which it is preferable to run the motor. It is noticeable that in the smaller units, alternating-current machines usually run considerably faster than direct-current machines of the same horse power. Above 100 horse-power output, the speed of electrical machinery becomes considerably more standard.

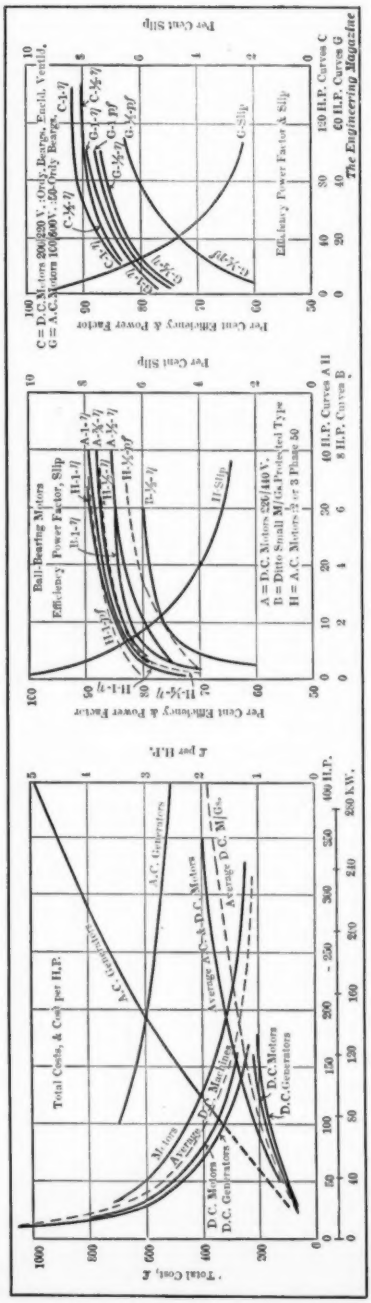

Per Cent Slip
Per Cent Efficiency & Power Factor
Ball-Bearing Motors
Efficiency
Power Factor, Slip
A = D.C. Motors 220/440 V.
B = Ditto Small Mica Protected Type
H = A.C. Motors 3 Phase 80
10 H.P. Curves A H
8 H.P. Curves B
C = D.C. Motors 200/220 V. Only Bearings Encld. Ventild.
G = A.C. Motors 100/600 V. Ball Only Bearings
150 H.P. Curves C
60 H.P. Curves G
Efficiency Power Factor & Slip
The Engineering Magazine
£ per H.P.
Total Cost, £
Total Costs, & Cost per H.P.
A.C. Generators
A.C. Motors
Average A.C.
Average D.C. Machines
D.C. Motors
D.C. Generators
100 H.P.
250 K.W.

FIG. 5. AVERAGE CURVES OF COST AND OUTPUT, DIRECT- AND ALTERNATING-CURRENT MACHINES.

FIGS. 6 AND 7. EFFICIENCY, POWER FACTOR AND SLIP, MOTORS WITH BALL AND ORDINARY BEARINGS.

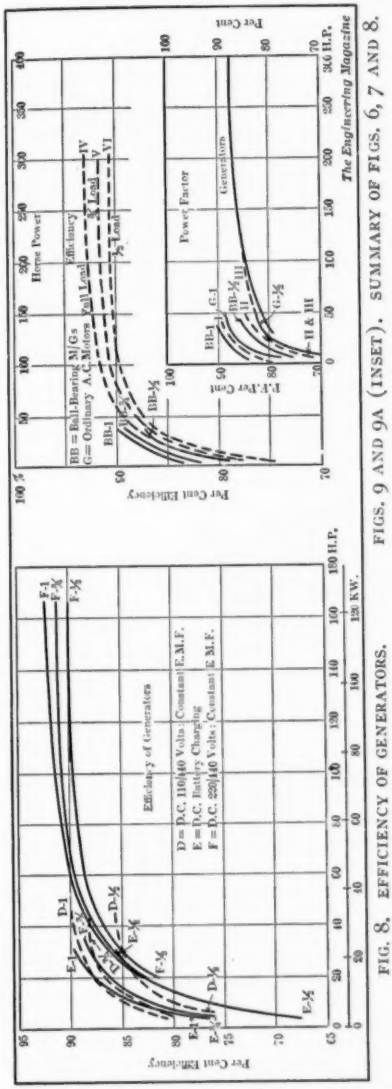
The dotted weight curve is representative of average practice. Its slight concavity shows that the weight increases rather more rapidly than if it were strictly proportional to the horse power, the effect of increasing material to provide for mechanical rigidity.

The main points to be noted in regard to the curves in Figure 2 are the rapid decrease in cost per horse power as the total horse power of the motor increases, and the cheapness of alternating-current motors, particularly of the short-circuited rotor type. The costs in these curves refer to ball-bearing motors, but the costs are little different if ordinary bearings are specified. In Figure 3, giving cost-output curves for generators, the high cost per horse power of some of the smaller units is again to be noted.

Figure 4 deals with four types of alternating-current generators of outputs ranging from 2 to 300 kilowatts. The ascending order of total cost is:—direct-coupled two- or three-phase machines; belt-driven two- or three-phase machines; single-phase direct-coupled machines; and single-phase belt-driven machines. The ascending order of the weights is the same as that of the costs. For the sake of clearness, only the mean cost per horse power for the four types have been plotted. It will be seen that the specific costs are here considerably greater than in Figures 2 and 3, though the type of curve is unaltered.

In Figure 5 are collected the chief results of Figures 2, 3 and 4, together with other information, covering a range of horse power from 10 to 400. From these curves it appears that direct-current motors are cheaper than alternating-current machines, except in small units, though this statement must not be accepted as final. The dotted curves may be accepted as sufficiently accurate for any normal alternating- or direct-current machines within the range of horse power dealt with.

Mr. Crouch prefaces his comment on the remaining curves with a brief discussion of the importance of high efficiency and power factor. These curves deal with the efficiency and power factor obtainable under various conditions of loading. The capital letters refer to the



FIGS. 9 AND 9A (INSET). SUMMARY OF FIGS. 6, 7 AND 8.

FIG. 8. EFFICIENCY OF GENERATORS.

keys inset in the various figures, the numerals ½, ¾ or 1 refer to one-half, three-quarter or full-load test respectively, η means that the curve deals with the efficiency of a machine, and *pf* denotes that the power factor is the function dealt with.

Figure 6 shows that over the range of horse power treated there is little to chose between direct- and alternating-current machines, the latter having the advantage, particularly at half load. The very considerable drop in efficiency at outputs below 10 horse power is a further disadvantage consequent on the use of small machines. It is to be noted that the power factor falls considerably faster than the efficiency as the load falls from its normal value. The fall in efficiency from full to three-quarter load is usually only one-half to two-thirds that occurring between three-quarters and one-half full load, a very desirable distribution.

The curves in Figure 7 show the generally acknowledged superiority of direct-current motors in the matter of efficiency of larger units. The very considerable fall in power factor of alternating-current motors from full to half load is again shown, more serious in this case chiefly owing to the greater slip. The efficiencies in general are the same as in Figure 6.

Figure 8 deals with the efficiency of generators, the curves shown being based on three types of machine covering a range of outputs from 3 to 180 horse power. The efficiencies agree closely with those given for direct-current motors in Figures 6 and 7. It is again apparent from the curves in Figure 8 that the three-quarter-load efficiency is greater than the mean of the full- and half-load efficiencies.

Figures 9 and 9A form a convenient summary of the results expressed in full by Figures 6, 7 and 8. Ball-bearing machines are discriminated from those fitted with ordinary bearings. The power factors of alternating-current machines are summarised in the inset diagram 9A. The dotted curves I and II, Figure 9A, show the mean power factors to be expected from normal alternating-current motors on full and half-load respectively, while curve III deals with alternating-current generators of the type already referred to in Figures 4 and 5. The efficiency curves IV, V and VI, Figure 9, show reasonable values to be assumed for the efficiency of electrical machinery in general (with the exception of those machines fitted with ball bearings) on full, one-half and three-quarter load respectively.

TELEGRAPHIC TRANSMISSION OF PICTURES.

A BRIEF DESCRIPTION OF THE THREE LEADING SYSTEMS OF PHOTO-TELEGRAPHY.

T. Thorne Baker—Royal Society of Arts.

THE photo-telegraphic systems now in commercial use are all based on the researches of Bakewell, who attempted experimentally the solution of the problem of transmitting pictures electrically as early as 1847, and of the later investigators, Caselli, d'Ardres, Bidwell, Eaton, Amstutz, and Kiszelka. The establishment of the commercial utility of photo-telegraphy, however, did not occur until 1908, when the Korn system was installed between the offices of the *Lokal Anzeiger* in Berlin, *Illustration* in Paris, and the *Daily Mirror* in London. Some interesting details of the leading systems now in use, particularly that of Professor Korn, whose selenium process was the first to reach a practical stage, are given in a paper by T. Thorne Baker, read before the Royal Society of Arts and published in the *Journal* for November 26, 1909.

Professor Korn's process is based on the discovery of Shelford Bidwell that the electrical resistance of the metal selenium, when in a certain physical state, increases inversely with the amount of light which falls upon it. An enlargement of the photograph to be transmitted is printed on a sheet of transparent celluloid, which is wrapped around a revolving hollow glass cylinder. The rays of a Nernst lamp are focused upon the photograph by means of a lens, and after passing through the film and cylinder are deflected by a prism fixed inside the cylinder on to a selenium cell. The cylinder, as it revolves, rises spirally, and the density of each successive portion of the photograph, as it passes the point of convergence of the rays of light, varies the intensity of the light which traverses it. Hence the light falling upon the selenium cell varies in exact accordance with the density of the portion of the photograph traversed by the rays at any instant, and an electric current passing through the selenium, whose resistances changes when illuminated, varies each instant also in accordance with the tones of the photograph.

The changes in resistance of the selenium, however, do not respond quickly enough to the changes in density of the photograph. To overcome this defect, Professor Korn causes two selenium cells, one of high, and other of low, inertia, their resistance being low and high respectively, to be illuminated simultaneously; the lag in one cell counteracts that in the other. These cells are connected in series, and the two are connected bridge fashion with the receiving galvanometer. The lag in the physical action is greatly overcome because the current depends on the sum of the effects of the cells on each side of the bridge, and when illumination ceases the current falls to zero.

The receiving galvanometer consists of a large electro-magnet with a hole bored through the poles. Opposite the centre of the hole, a small magnesium shutter is attached to two fine silver wires 0.001 inch thick stretched between the poles. The current passes through these wires (which are in parallel) and a lateral displacement takes place, there being practically no torque, so that the shutter moves aside and rays from a second light can pass through to a sensitive photographic film on a second revolving cylinder. In transmitting, a prism is placed in the path of the rays, which deflects them downward on to the compensating selenium cell. It is in this way that the compensating cell is illuminated, as the moment light falls on the principal cell, current passes through the galvanometer and light is allowed to fall also on the second selenium cell. In receiving, however, the prism is removed and the light falls upon the sensitive film. The shutter moves aside more or less according to the current received from the transmitting station. Hence the light concentrated optically upon the revolving film is more or less intense according to the light and shade in the photograph being transmitted. The development of the film produces a photograph similar to that used at the sending station.

The transmission troubles in working with a line voltage of about 200 volts in a circuit where the maximum current received is about one milliampere are sometimes very great. A closed circuit is necessary and hence telephone lines are employed. The first pictures were transmitted by Professor Korn from Berlin to Paris in October, 1907, and from Paris to London in November of the same year.

Later Professor Korn devised a telautograph, by adapting a Caselli transmitter to a modification of his own galvanometer, by means of which line drawings can be transmitted with remarkably good results. The picture is drawn in gum or shellac lines on a copper sheet which is attached to a metal drum revolving spirally at the rate of 330 revolutions per minute under a steel tracer or style. The metal drum is connected to one end of a battery (about 60 volts), the other end of which is connected to one of the telephone lines; the other telephone line is connected to the style. The interruptions of the current caused by the passing of the gum lines beneath the style are utilized to build up a photographic image in the receiver. The receiver consists of a revolving drum to which a sensitive film or piece of paper is attached. The light from a Nernst lamp traverses a hole bored through the poles of the electro-magnet and falls on a fine slit; over this slit falls the shadow of a fine flat wire which is stretched across the optic path and is free to rise and fall between the poles. When the wire is in the normal position, the slit is covered with its shadow. When current flows in the line, it flows through the wire, which is thereupon displaced, the shadow is thrown off the slit, and light passes through it and is concentrated on the sensitive film. At each line in the sketch being transmitted, therefore, the current is interrupted, the shadow falls upon the slit, and the film remains unexposed. When the film is developed, a negative photographic image of the sketch is produced. A positive image may be received direct on bromide paper.

Photographs split up into lines by means of a single-line half-tone screen can be transmitted by the Korn telautograph and many experiments are now being made to improve their quality. One of the drawbacks so far has been that the half-tone screen contains a definite number of lines to the inch, and that therefore a regular train of impulses is sent into the fine wire in the receiving galvanometer, which tends to swing with a definite frequency, and so not to correspond exactly with the width of the lines, upon which the tones or shades in the photograph entirely depend. The results so far obtained, however, are very promising.

Quite recently some very successful results have been obtained by M. Belin, of Paris, whose transmitter is based on that of Amstutz. In the Belin system, a gelatine relief photograph, such as is prepared by printing from a negative upon paper coated with a sensitive mixture of gelatine and a bichromate, is attached to a cylinder and revolved spirally. A metal style, attached to the membrane of a microphone, presses against this cylinder. As the photograph revolves, different thicknesses of the gelatine press against the style, owing to the varying relief, and the membrane is pressed more or less inwards. This varies the magnetic field as speaking does in the ordinary telephone, and the varying current is sent to the receiving station.

"The receiver consists of a light, a galvanometer, and a drum, to which a sensitive photographic film is attached. The galvanometer is a Blondel oscillograph, in which two fine phosphor-bronze wires pass between the poles of an electro-magnet, a small mirror being attached to them in the central part of the magnetic field. This mirror is so arranged that it reflects light from a Nernst lamp on to a diaphragm with a rectangular aperture over which is placed a piece of glass varying from practically complete to small transparency, so that the more the mirror is deflected the more the beam inclines to the very transparent side of the graduated glass. What light does pass through is concentrated by a lens as a small spot on the sensitive film, and in this manner a photograph is obtained, the movements of the mirror corresponding to the pressure on the microphone."

In Mr. Baker's own system a Caselli transmitter is employed, as in the telautograph, but the half-tone photographs are printed in fish glue upon lead foil, and the lines are pressed into the soft metal, so that there is no friction at the style. This tends to give better synchronism and prevents vibration of the style. The receiver is very simple, and is, in appearance, the facsimile of the transmitter. A piece of chemically prepared paper is wrapped around a metal cylinder and the current received is passed through the style into the cylinder through the paper. Every time the current flows, a chemical mark appears on the paper by electrolytic action. The paper is sufficiently sensitive to record five or six hundred dots a second, while the receiver is fitted with a simple regulating device by means of which the distortion of the currents caused by their passage through a long-distance line can be completely overcome.

Mr. Baker believes that by means of his selective selenium apparatus Professor Korn is likely to find a practical solution of the problem of transmitting pictures over distances as great as from London to New York. Mr. Baker himself is attempting to solve the same problem by means of wireless, and in conclusion he describes some of his experiments and the wireless arrangement which so far has given most promise of success.

THE HUMPHREY GAS PUMP.

A BRIEF DISCUSSION OF ITS POSSIBILITIES IN THE COMPRESSION OF AIR AND IN POWER PRODUCTION.

Herbert A. Humphrey—Institution of Mechanical Engineers.

LAST month we devoted some space in these columns to a description of an internal-combustion pump invented by Mr. Herbert A. Humphrey and a report of some highly economical results obtained in a series of official trials conducted by Professor W. C. Unwin. Since the publication of the article in *Engineering* upon which our review was based, Mr. Humphrey has presented to the Institution of Mechanical Engineers a paper dealing exhaustively with the theoretical and practical aspects of his invention. The principle of the pump was sufficiently well shown in our review last month. We limit the following extracts from Mr. Humphrey's paper to his discussion of the possibilities of the internal-combustion pump in air compression and power production.

"The extreme flexibility of the system is shown by the readiness with which it can be adapted to the case of compressing air. The column of liquid which reciprocates backward and forward from and to the pump can be made to enter an air-compressor chamber fitted with suitable valves attached to the end of the discharge pipe. The energy of the moving column of water is utilised to compress air, and also to store sufficient energy in an elastic cushion to produce a return flow towards the pump to give the compression stroke. This movement of the column also serves to draw a fresh quantity of air into the compressor." The action may be seen from the accompanying diagram of a compressor attached to a four-cycle pump and its explanatory caption.

"Naturally, the two-cycle pumps (described in Mr. Humphrey's paper) are better suited for this class of work than the four-cycle pumps, and it should not be overlooked that as there is no solid piston the space in the top of the air-compressor chamber may contain vertical sheets of wire gauze which hold water and present a very large contact surface for cooling the air and rendering the compression almost isothermal. The water which abstracts the heat does not remain in the chamber, for, in the case where water may be taken in or discharged at valves placed one close to the pump and one close to the compressor, an arrangement which gives greater elasticity in meeting all possible conditions, an automatic circulation through a cooling tank is set up. It is only necessary to make the tank of sufficient capacity to effect the required cooling."

The efficiency of the system suggests the possibility that, as it comes to be further developed in the future, "internal-combustion pumps may be substituted for gas engines in central electric power stations. If the water pumped is passed through an ordinary water turbine driving an electric generator, and the water is then returned to the pump to be used over and over again, we arrive at a gas-power system with the water forming a hydraulic coupling. Even now the combination of the pumps with water turbines gives far greater economy than that reached by any internal-combustion turbine so far constructed."

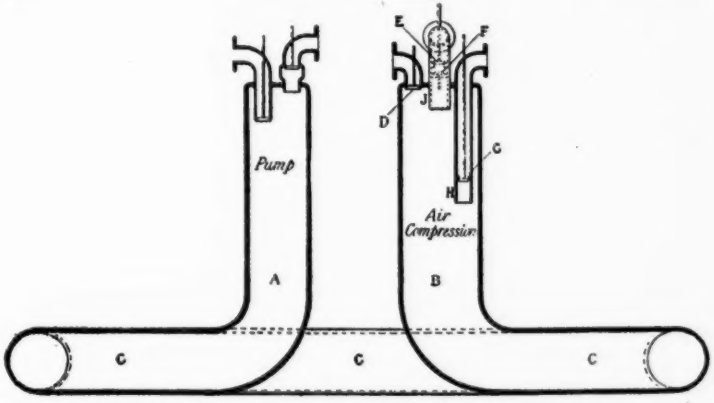


DIAGRAM OF A PUMP USED FOR DRIVING AN AIR COMPRESSER.

The pump chamber A is connected to the compressor chamber C, and the quantity of reciprocating water is such that when the level is high in the pump chamber it is low in the compressor chamber. The air-compressor chamber is fitted with an inlet valve D, an outlet valve E, and two other valves F and G, which normally remain open under their own weight, and are so placed and constructed that they allow air to pass them but not water, since the impact of the latter is sufficient to close these valves. Suppose A to contain a compressed combustible charge and B to contain a charge of air at atmospheric pressure. Ignition of the charge in A drives outwardly the column of water, so that the level rises in chamber B. Air escapes through the open valve G while the gases are expanding and imparting kinetic energy to the moving column, but as soon as the water reaches the bottom of pipe H, which projects into the chamber, it closes the valve G in its attempt to rise in the pipe. The remaining air is then compressed to the pressure at which air is discharged. When this point is reached the valve E opens and air is delivered under pressure. When the water reaches the level of pipe J and attempts again to escape into the air, it shuts the valve F, and there being no further outlet, the imprisoned air is cushioned and the water column brought to rest. The expansion of the cushion causes a reverse flow which drives the products of combustion from the pump chamber, gives the cushion stroke in that chamber and causes the cushion expansion and suction stroke which follows. As the water level falls in chamber B, valves F and G fall by their own weight. By altering the extent to which pipe H projects into the air chamber, the quantity of air acted upon may be varied and the work of the compressor adjusted to supply a greater quantity of air at lower pressure or a less quantity of air at a greater pressure.

Mr. Humphrey gives a diagram showing the possible arrangement of one unit of a plant of this kind, the other units being arranged side by side. "The pump discharges through a valve box situated in the suction tank. This tank serves also as an isolating tank. The discharge pipe conveys the water into a large air vessel placed outside the building. This air vessel is connected at the top with other similar air vessels by a common air pipe, which maintains the air pressure the same in all the vessels, and at the bottom with a common water main. The water is fed to the turbine by a pipe, and the turbine discharges into a longitudinal canal which has a connection to each of the suction tanks. The turbine is direct coupled to an electric generator. The gas main supplying all the units of the plant runs longitudinally outside the building.

"The advantages of such an arrangement are fairly obvious, and arise chiefly from the simplicity of the working parts, the absence of noise and shock, and from the exceedingly low cost of upkeep. In

gas-engine stations using cheap producer-gas or blast-furnace gas the cost of lubricants and stores frequently exceeds the cost of the fuel, but in the present instance there is practically no lubrication required, and the author has worked one of his pumps for a week at a time with absolutely no lubrication whatever. Of course, one has to face the loss due to the conversion of the water power into mechanical energy, but the efficiency of a well-designed turbine is not less than 80 per cent. at full load, and there is no need to work any of the pumps at less than full load. The ease with which the pumps can be started and stopped from the switchboard gives the electrician complete control of his station and the ability to start up one or more pumps at a moment's notice. In fact, even this arrangement can be simplified, because the governing of the pumps can be so arranged that a steady pressure is kept on the air-vessels irrespective of the demands, and a slight rise in this pressure may automatically cut out one pump and its attached dynamo after another, and restart them again as the pressure falls. Based on the efficiencies so far obtained, a Board of Trade unit can be generated for 2 pounds of anthracite coal, and with the large units of plant required in central stations this figure should be much reduced. Even if the fuel economy should not prove to be higher in such a station, yet its other advantages may more than compensate for this defect. One other aspect of this question might be mentioned, and that is, if the contour of the district is such as to permit the construction of a high-level reservoir of considerable capacity in proximity to the pump-house, water can be pumped into this reservoir and be drawn upon as required. This would enable the pumps to work steadily day and night on a 100 per cent. load factor, and would reduce the quantity of gas producer and pump equipment to the minimum possible.

"If the internal-combustion pump proves in the future to be a successful competitor of the gas-engine for power purposes, then it is probable that one of the most useful fields for its employment will be found in the propulsion of ships. Quite apart from the possibility of driving a turbine attached to a screw-propeller, there is the much more efficient jet-propeller, which is the most efficient of all propellers for ships if properly constructed and operated. What has been lacking so far has been a type of pump capable of delivering very large quantities of water at comparatively low heads, and it is just these conditions which suit the author's pumps in their simplest form."

THE EFFICIENCY OF LINE SHAFTS.

A DETERMINATION OF THE IMPROVEMENT IN MECHANICAL AND ECONOMIC EFFICIENCY TO BE OBTAINED BY THE SUBSTITUTION OF BALL BEARINGS FOR ORDINARY BEARINGS.

Henry Hess—American Society of Mechanical Engineers.

IN the average plant, journal friction, including the losses at the loose pulley bearings and the countershafts, accounts for at least nine-tenths of the total losses in power transmission by means of line shafts. The coefficient of friction of plain babbitted or of cast-iron bearings ranges all the way from 0.5 to 8 per cent. The lower value is rarely realized outside of the laboratory, and the higher is found by no means infrequently. A reduction of the coefficient of friction to 3 per cent represents careful and vigilant management. It is generally known that an improvement in efficiency can be obtained by the substitution of ball bearings for plain bearings, but exact data for the calculation of the economy of installing the more expensive system have not been available. To supply this deficiency a series of comparative tests has recently been concluded for Mr. Henry Hess, who communicated the results to the American Society of Mechanical Engineers at the recent annual meeting. The tests were arranged to involve no variables other than the bearings themselves, and to eliminate possible personal bias in favor of the ball bearings, Mr. Hess turned the whole

investigation over to the firm of Dodge and Day. The results, in Mr. Hess' opinion, give definite and reliable information of the comparative economy of plain and ball bearings under practical shop conditions.

The tests were made on a line shaft, 2 7-16 inches in diameter and 72 feet long, supported by 10 hangers with an average spacing of 8 feet, used to operate a series of heavy turret lathes. The shaft was equipped alternately with plain ring-oiling babbitted boxes and Hess-Bright ball-bearings. Power was supplied by a 10-horse-power motor; constancy of shaft speed was assured by the insertion of a rheostat in the field of the motor and by the use of a Warner tachometer. The belts from the eight driving pulleys on the shaft drove loose pulleys mounted on swings, the tension in the belt being definitely determinable in each case. The effect of varying loads was determined, for both plain and ball bearings, by changing the belt tension by approximately equal increments from 20 to 90 pounds per inch width of single belt. This was supplemented by a test with all of the belts removed except the driving belt from the motor, leaving only the weight of shaft and pulleys for journal loads. The loads on the line-shaft journals ranged from 126 to 662 pounds per journal; for the 2 7-16-inch by 10-inch ring-oiling babbitted bearings this gives loads ranging from 5.2 to 27.3 pounds per square inch of projected area. The ball bearings used had each 12 balls 9-16 inch in diameter. The load per ball was from 10.5 to 55.2 pounds. Each test lasted 40 minutes of running time, and readings of the various instruments and meters were taken every two minutes.

Details of the results are given by Mr. Hess in four tables. The savings in power indicated as being due to the ball bearings in the various tests ranged from 14 to 65 per cent. In his opinion, the conditions of loading in this series of tests included those of general practice and he believes that it may be safely inferred that such savings may be generally realized. Mr. Hess proceeds, however, to the derivation of constants that may be applied in any set of conditions. To this end he compares the actual losses with the losses calculated from certain assumptions of friction coefficients for plain and ball bearings for line shafts and for countershafts. His conclusions are as follows:

"(1) Savings due to the substitution of ball bearings for plain bearings on line shafts may be safely calculated by using 0.0015 as the coefficient of ball-bearing friction, 0.03 as the coefficient of line-shaft friction, and 0.08 as the coefficient of countershaft friction.

(2) When the belts from line shaft to countershaft pull all in one direction and nearly horizontally, the savings due to the substitution of ball bearings for plain bearings on the line shaft may be safely taken as 35 per cent of the bearing friction.

(3) When ball bearings are used also on the countershafts, the savings will be correspondingly greater and may amount to 70 per cent or more of the bearing friction.

(4) These percentages of savings are percentages of the friction work lost in plain bearings; they are not percentages of the total power transmitted. The latter percentage will depend upon the ratio of the total power transmitted to the power absorbed by friction in the line and countershafts.

(5) The power consumed in the plain line and countershafts varies, as is well known, from 10 to 60 per cent in different industries and shops. The substitution of ball bearings for plain bearings on the line shaft only, under conditions of paragraph (1) will thus result in savings of total power of 3.5 to 21 per cent. By using ball bearings on the countershafts also, the saving of total power will be from 7 to 42 per cent."

In conclusion Mr. Hess gives an estimate of the return on the extra investment involved in installing ball bearings to secure this saving in power. Based on average conditions in the tests under review, the estimated return, taking the saving in power alone into consideration, is 27 per cent per annum. Taking into account all the elements, including depreciation, maintenance and labor, the estimated return rises to 37 per cent per annum.

THE PREVENTION OF COAL MINE ACCIDENTS.

EXCESSIVE COMPETITION IN THE COAL TRADE THE UNDERLYING CAUSE OF WASTEFUL AND UNSAFE MINING METHODS.

J. A. Holmes—National Civic Federation.

THE coal industry of the United States, says Mr. J. A. Holmes, Chief of the Technologic Branch of the United States Geological Survey, in a recent address before the National Civic Federation, represents a great host of scattered, warring, discouraged elements, without organization or cooperation, which existing Federal and State laws make it impossible to unite or reconcile. To the ruinous competition forced upon coal producers by the prohibition of agreements which would place the price of coal at the mine on a reasonable basis, Mr. Holmes attributes, in great part, the prevalence of wasteful and unsafe methods of mining.

"The economic conditions upon which coal mining is based in this country," he says, "are fundamentally bad, and the evil consequences are so far-reaching as to both time and extent and are so essentially national in character, that this subject demands the earnest consideration of our best statesmen as well as of our best engineers.

"These conditions and their consequences may be summarized as follows:

(1) In spite of the rapid growth in our demand for coal, the normal productive capacity of our coal mines under continuous operation greatly exceeds this demand.

(2) Ruinous competition exists not only between the operators in the same field, but between the operators of one field as against those in another field, or in another State, where different mining laws and regulations exist.

(3) This competition is first of all driving out of the business the small operators, except where they find protection under local freight rates, and is forcing even the larger operator to mine coal under conditions which he cannot approve but from which he finds no escape. If he and his fellow-operators endeavor to 'get together' and place the price of coal at the mine on a reasonable basis they go to jail under either a Federal or a State statute; and as the only alternative each must live (or succumb) by underbidding the other, which he can do only through wasteful and unsafe mining methods.

(4) Even when the demand for coal and the prices are at their best, under existing conditions, the operator can mine only that part of his coal which can be taken out most cheaply and sold at higher prices, and the remainder must be left underground in such shape as may possibly preclude its future recovery. And thus we waste yearly more than 250,000,000 tons of the Nation's fuel supply.

(5) The American mine owner is as humane as is the mine owner of any other country, and he would like to follow every practice and use every appliance for safety to be found in Britain, France, Belgium, Germany, or elsewhere; but he pays his miners higher wages, and at the same time receives for his coal at the mine less than half the price received for similarly mined coal by the operator in these countries, and he must employ miners an increasingly large percentage of whom come to him unfamiliar either with the practices of the industry or with the language or traditions of the country.

(6) And the penalty which the Nation is paying for this bad system is this increasing waste of resources and the still more unpardonable increasing waste of human life—the yearly loss of 250,000,000 tons of coal, and the killing or injuring yearly of from 8,000 to 10,000 men.

"And what are the remedies for this bad situation?

(a) Investigations, such as are now being conducted by the Government, as to the causes of mine explosions, and other similar investigations as to the causes of mine accidents of other kinds and as to methods of prevention.

(b) Educational work among the miners and the lower active mine officials as to these causes and remedies.

(c) The training of men at each mine as to the best method of using explosives, using electricity, handling of gases and dust, timbering, preventing and extinguishing mine fires, the methods of rescue work, and the methods of first aid to the injured.

(d) The development of better and more uniform mining laws, rules and regulations, based upon accurate data and experience.

(e) Active, determined co-operation between the miners and the mine management and the state inspectors in the enforcement of these regulations with a view to the maintenance of the safest possible conditions in every mine.

"The above are all parts of the program for lessening and alleviating mine accidents, but they do not complete the program. It is an essential part of this program that the ruinous competitive system upon which coal mining in the United States is based at the present time should be changed, and that the price paid for coal at the mine should be such as will permit and secure safe and efficient mining. All this can be done without adding appreciably to the burden of the average American citizen, without any increase in the price of coal at the poor man's cottage and without the risk of any unreasonable restraint of trade.

"There can be no permanent industry without reasonable profits. It is unjust and irrational that in this great and essential branch of industry, reasonable profits should be dependent upon any unnecessary sacrifice of human life, and unnecessary waste of resources which we can neither replace nor restore and which will be essential to the future development of the country.

"This industry needs and deserves fair treatment at the hands of the American people, and upon its receipt of such treatment depends in no small degree not only the welfare of the operators—though nobody cares about them—but also the welfare of the 600,000 miners who risk their lives in supplying the fuel for the Nation's industries, and the heat and light for the Nation's comfort and convenience."

LUMINOUS REPEATING SIGNALS FOR FOG.

A DESCRIPTION OF A NEW SYSTEM INSTALLED ON THE BELGIAN STATE RAILWAYS.

L. Weissenbruch and J. Verdeyen—International Railway Congress.

A SYSTEM of fog signalling, which is reported by the chief engineer to enable drivers "to run at the same speed and with the same degree of safety in the densest fogs as they could in clear weather," has been in operation on the Brussels-Antwerp line of the Belgian State Railways since June, 1908. Compared with the majority of fog signalling methods, both acoustic and luminous, the system is one of extreme simplicity. It consists in the establishment in advance of each signal of a sufficient number of luminous relays, located as near as possible to the track and at the level of the eye of the engineer, to ensure that the signal will be caught under even the most unfavorable atmospheric conditions. A few details of the installation are taken from an exhaustive description by L. Weissenbruch and J. Verdeyen, in the *Bulletin of the International Railway Congress* for October.

The recent standardization of the general signalling system of the Belgian State Railways has involved the following changes in the equipment as first installed:

(1) The replacement of the distant signal, a rectangular disc not to be overrun in making a stop, by a caution distant signal, which may be overrun in making a stop, in the form of a semaphore arm with a V-pointed end;

(2) The replacement of the round disc protecting the entrance to stations by a semaphore signal fitted with arms of rectangular shape showing a green light for road clear and a red light for danger (stop);

(3) The establishment in front of each block signal (requiring absolute stop) a caution distant signal showing a green light for road clear and a yellowish orange light for caution (block signal at danger).

The Brussels-Antwerp line was chosen for the first application of the standard system, which was completely installed before the establishment of the luminous repeating fog signals was decided upon. Several arrangements of the luminous relays in relation to the distant and block signals were experimented with, which included various combinations of fixed and changing lights. In the system finally adopted, three changing lights are located in advance of each distant signal and two changing lights in advance of each block signal. The distance on the level between the distant signal and the danger point is 900 metres; the block signal is located 100 metres in advance of the danger point. The luminous relays are spaced 150 metres apart and the same distance from the distant and block signals. Their height above the rail is 2 metres, and their distance from the track, 1.50 metres. At junctions the luminous repeaters of the junction signals are arranged as double lights, spaced 90 centimetres apart. It is obvious that when interlocking gear connects the block and distant signal, only the latter requires to be equipped with repeaters. The interlocking gear prevents the distant signal being put to line clear while the block signal remains at danger.

"The distance from Brussels to Antwerp is only 44 kilometres (27.3 miles) and lighting stations are in existence at both ends and at the centre of the line. It was, therefore, possible to obtain current with little difficulty at each cabin. Moreover, in view of the exceptional density of the traffic, it was desirable to provide perfect lighting throughout, even though a rather high expenditure were involved. Finally, there was no time available for making trials of cheaper methods. It was accordingly settled to use electricity for lighting the luminous repeaters. In order to make success more certain, it was decided that each cabin should be independent of the source of supply and should be provided with an adequate storage; this made it necessary to instal a battery of accumulators at each cabin." The expense of operating the signals is so small, that the luminous relays are lighted when the atmospheric conditions are such that the signals are not visible at a distance of 200 metres, and under some conditions, at 350 metres.

As already noted, each distant signal is preceded by three luminous repeating signals which show a yellow orange light when the distant arm is horizontal, and a green light when it is in its inclined position. The signal lamps of the relays, which are carried on hollow cast-iron columns fixed on a small wooden foundation made of old posts, are divided into two parts, each containing an electric lamp and a powerful reflector; one compartment of the lamp is fitted with a yellow glass, and the other with a green glass. The lamps of the same color of the three repeaters are arranged in series and the two series of lamps are arranged in parallel on a 120-volt circuit. In the case of block signals which are preceded by only two luminous repeaters the scheme of conection is the same; to enable the same lamps to be used throughout, a compensating resistance equal to that of the third lamp is introduced.

The battery of accumulators installed at each cabin consists of 60 Tudor cells; it has sufficient storage capacity to ensure the regular operation of the signals for a period of three or four days without recharging. In foggy weather, it is capable of operating the signals for a whole day and of lighting the luminous repeaters for several hours. The lamps of the luminous relays are of 10 candle power and work at 33 volts. They are of the Edison type and each circuit of three lamps arranged in series consumes about 0.7 amperes. On a short stretch of the line these lamps have been replaced by tantalum lamps of the same candle power and worked at 35 to 36 volts. With the tantalum lamps the current is reduced to 0.4 amperes per circuit. The visibility of the luminous repeating signals in the daytime in foggy weather depends mainly on the form of the filament, which is visible to the driver as a luminous line. In this respect the metallic-filament lamps are better than the Edison lamps used in the first instance. Their higher first cost is to a great extent compensated for by these two advantages of greater visibility and higher current economy.

THE COST OF TIMBER PRESERVATION.

A COMPARISON OF THE SEVEN LEADING PROCESSES FOR THE TREATMENT OF RAILWAY TIES, WITH DETAILED COSTS OF FOURTEEN TREATMENT PLANTS.

G. B. Shipley—Engineering News.

A COMPARATIVE study of the seven leading processes of timber preservation, contributed by Mr. G. B. Shipley to *Engineering News* for October 14, 1909, contains the most numerous and exact cost data of this subject that have come to our notice. These data, which include average costs of tie timber and piling treatment by each of the seven processes in extensive use, and detailed installation costs of fourteen typical plants ranging in capacity from 800,000 to 15,000,000 cubic feet per year, we reproduce in full. The other points touched upon by Mr. Shipley are recapitulated, necessarily very briefly, in the following abstract of his paper.

Mr. Shipley is concerned with preserving processes chiefly as applied to railway ties, and he introduces his subject with an estimate of the saving to be effected through the use of treated ties. He assumes the useful life of a tie untreated as 5 years; treated, as 12 to 15 years. The first cost, assumed at $0.50, and the cost of laying, assumed at $0.15, will be the same in both cases. Allowing $0.35 for the cost of treatment, the treated tie will cost laid in the track, $1, compared with $0.65 for the untreated tie. Adding compound interest at 4 per cent. for 15 and 5 years, respectively, the costs for the useful lives of the ties are $1.80 and $0.79. Hence, the annual depreciation in the case of the treated tie is $0.120, and in the case of the untreated tie, $0.158. The treated tie, therefore, saves in maintenance costs $0.038 per year. The saving per mile of track containing 2,880 ties will be $190.44, and a timber treating plant with a capacity of 1,000,000 ties per year will make an annual saving of $38,000.

The processes of timber preservation which have been suggested and tried are very numerous. Those which have been extensively applied may be reduced to the seven described in bare outline below, after Mr. Shipley's much more detailed discussion.

1. Burnettizing process. Air-seasoned wood is impregnated with a solution of zinc chloride until each cubic foot has taken up about ½ pound of the dry salt. Following a steaming process to expel moisture, the wood is subjected to a vacuum which is maintained until the solution is introduced and the wood is completely submerged. By pumping in additional solution, the pressure is then raised to 100 to 125 pounds per square inch; this pressure is maintained until the desired penetration and impregnation have been obtained. The time required for the whole cycle of operations varies from 5 hours 15 minutes to 7

CAPACITY OF TIMBER PRESERVING PLANTS.

Plant No.	Size of Plants. Cylinders. Number.	Diam., ins.	Length, ft.	Capacity Per Year of 300 Days Treating Processes. 3 Charges to Each Retort Per Day of 24 Hours. Burnettizing, Wellhouse, Card and Full Cell. No. of Ties.	Cu. Ft.	Thousand Ft. of Lumber.	4 Charges to Each Retort Per Day of 24 Hours. Rueping and Lowry. No. of Ties.	Cu. Ft.	Thousand Ft. of Lumber.
1	1	74	42	171,000	598,500	7,182	228,000	798,000	9,576
2	1	74	50	205,200	718,200	8,618.4	273,600	957,600	1,491.2
3	1	74	108	273,600	957,600	11,491.2	346,800	1,213,000	14,556
4	1	74	132	540,000	1,890,000	22,680	720,000	2,520,000	30,240
5	2	74	132	1,080,000	3,780,000	45,360	1,440,000	5,040,000	60,480
6	3	74	132	1,620,000	5,670,000	68,040	2,160,000	7,560,000	90,720
7	4	74	132	2,160,000	7,560,000	90,720	2,880,000	10,080,000	120,960
8	5	74	132	2,700,000	9,450,000	113,400	3,600,000	12,600,000	151,200
9	6	74	132	3,240,000	10,340,000	124,080	4,320,000	15,120,000	181,440
10	1	84	108	585,000	2,047,500	24,570	780,000	2,730,000	32,760
11	1	84	132	720,000	2,520,000	30,240	960,000	3,360,000	40,320
12	2	84	132	1,440,000	5,040,000	60,480	1,920,000	6,720,000	80,640
13	3	84	132	2,160,000	7,560,000	90,720	2,880,000	10,080,000	120,960
14	4	84	132	2,880,000	10,080,000	120,960	3,840,000	13,440,000	161,280

APPROXIMATE COSTS OF COMPLETE TIMBER PRESERVING PLANTS.

Plant number	1	2	3	4	5
Acres required for complete plant and yard	7	8	10	20	39
Total ties	170,000	205,000	260,000	540,000	1,080,000
Storage: Equivalent in 1,000 board ft. of lumber	7,040	8,490	10,770	22,400	45,000
Capacity:					
Creosote in gallons	110,000	133,000	168,000	350,000	700,000
Water in gallons	7,200	8,500	11,000	22,500	45,000
Total miles of track in yard	1.00	1.23	1.23	2.8	5.6
Length of loading platform	126 ft.	150 ft	325 ft.	400 ft.	400 ft.
Weight of equipment in tons:					
Machinery	61.00	70.00	131.00	163.00	278.00
Creosote tanks	24.30	29.00	36.50	45.00	90.00
Water tanks	3.00	3.70	4.80	9.70	17.50
Tram cars	25.00	28.30	61.00	75.00	148.00
Fire service	11.50	13.80	17.20	35.80	71.60
Yard hoists	3.60	4.00	7.50	9.00	18.00
Steel buildings	15.00	17.80	27.20	30.00	37.40
Tracks	105.00	130.00	130.00	294.00	590.00
Total	248.40	296.40	415.20	661.50	1,250.50
Cost of land, buildings and equipment:					
Machinery	$10,600	$13,200	$21,200	$25,700	$42,000
Creosote tanks	1,900	2,260	2,850	3,900	6,950
Water tanks	360	440	570	1,160	2,100
Tram cars	1,980	2,340	4,860	6,000	11,820
Fire service	800	950	1,200	2,500	5,000
Yard hoists	600	700	1,200	1,500	3,000
Steel buildings	1,600	1,900	2,900	3,200	4,000
Excavating and foundations	1,150	1,350	2,000	2,250	2,800
Loading platform	630	750	1,625	2,000	2,750
Tracks	5,400	6,600	6,600	14,900	29,800
Land	700	800	1,000	2,000	3,900
Total	$25,720	$31,290	$46,005	$65,110	$114,120

Tie storage is based on 75 per cent. of the yearly capacity of plant, or 9 months' seasoning.

Creosote oil storage is equal to 60 days' supply when running.

Track is based on 60 pounds per yard rail. Steel at $30 per ton, ties at 50 cents each and laying track at 10 cents per foot.

Retorts are designed for working pressure of 250 pounds per square inch.

Plants are arranged for either burnettizing, Wellhouse, absorption, full cell, Rueping, Lowry or Card process.

Hoists are for transfering tram; if electrical locomotives are to be used, add or deduct in accordance.

Where plants are treating piling and timber it is necessary to have a traveling yard crane, which will cost about $5,000 to $7,000, depending on capacity.

hours 15 minutes, according to the duration of the steaming process. Per 1,000 board feet of lumber, 2,430 pounds of zinc-chloride solution, containing 41.67 pounds of the salt, are used. The cost of treatment per tie is about $0.12.*

2. Wellhouse process. An elaboration of the Burnettizing process. The wood is impregnated with a zinc-chloride solution containing about 0.5 per cent. of glue or gelatine to the same degree and by the same method as in the Burnettizing process. To solidify the zinc chloride, to prevent loss by leaching, this treatment is followed by the injection of a 0.5 per cent. solution of tannic acid, again by the same method. The time required varies between 6 hours 40 minutes and 8 hours 40 minutes, according to the duration of the steaming process. The cost per tie is about $0.16.

3. Absorption process. Air-seasoned wood is heated in an open or closed receptacle by a hot preservative at a temperature of 180 to 230 degrees F. After this treatment, which opens the pores, expels the air and moisture, and creates a vacuum within the wood, the receptacle is drained, and the wood is submerged in a cold preservative. Absorption of the latter is caused by the difference of temperature and by atmospheric pressure. The time of treatment of green timber is from 16 to 26 hours; of seasoned timber, from 7 to 14 hours. The cost per tie is about $0.23, using 6 pounds of creosote per cubic foot.

4. Full cell creosote process. Wood seasoned in the open or by steaming, usually both, is impregnated with 6 to 12 pounds of creosote per cubic foot in the case of ties, and with 10 to 20 pounds in the case of timber or piling, by the same method used in the injection of zinc-chloride solution in the Burnettizing process. The time required for the injection of 10 pounds per cubic foot varies, according to the amount of steaming necessary, from 5 hours 15 minutes to 7 hours 15 minutes. The cost

* Throughout this article, the estimated costs of treatment per tie are based on ties of average dimensions, 7 inches by 9 inches by 8 feet, in volume, 3.45 cubic feet. The cost of creosote is taken at $0.07 per gallon, and of zinc chloride, at $0.04 per pound. In addition to the cost of the preservative process, the expense of handling amounts to about 1½ cents per tie.

APPROXIMATE COSTS OF COMPLETE TIMBER PRESERVING PLANTS.

6	7	8	9	10	11	12	13	14
59	78	98	117	21	26	47	78	104
1,620,000	2,160,000	2,700,000	3,240,000	585,000	720,000	1,290,000	2,160,000	2,880,000
67,000	90,000	112,000	134,000	24,200	30,000	53,500	90,000	118,000
1,000,000	1,400,000	1,700,000	2,000,000	380,000	500,000	1,000,000	1,500,000	2,000,000
67,500	90,000	110,000	135,000	25,000	30,000	60,000	90,000	120,000
7.7	9.8	12.5	14.2	2.84	3.5	6.1	10.00	12.8
530 ft.	660 ft.	660 ft.	800 ft.	325 ft.	400 ft.	400 ft.	530 ft.	700 ft.
363.00	458.00	544.00	634.00	185.00	225.00	384.00	507.00	656.00
123.00	205.00	225.00	243.00	52.50	61.50	123.00	184.50	240.00
27.00	35.00	44.00	53.00	10.80	13.00	24.00	35.00	48.00
220.00	293.00	365.00	440.10	66.00	82.00	160.00	240.00	319.00
105.00	140.00	177.00	208.00	37.00	47.00	83.00	1,400.00	1,860.00
20.00	22.00	24.00	26.00	10.00	12.00	24.00	25.00	26.00
67.50	84.00	101.00	114.00	32.70	41.00	59.00	801.00	1,000.00
810.00	1,040.00	1,310.00	1,500.00	300.00	370.00	640.00	1,070.00	1,500.00
1,735.70	2,277.00	2,790.00	3,218.00	694.00	851.50	1,497.00	4,252.50	5,655.00
$54,400	$66,900	$79,400	$85,900	$28,900	$34,700	$57,800	$89,200	$109,800
9,500	16,000	17,600	19,000	4,100	4,750	9,500	14,250	19,000
3,260	4,200	5,230	6,300	1,290	1,550	2,870	4,200	5,740
17,580	23,400	29,160	35,040	4,290	6,500	12,805	19,045	25,350
7,300	9,800	12,400	14,500	2,600	3,250	5,800	9,750	13,000
3,200	3,400	3,600	3,800	1,600	2,000	4,000	4,200	4,400
7,200	9,000	10,800	12,000	3,500	4,400	6,300	8,600	10,700
5,000	6,300	7,600	8,400	2,450	3,100	4,400	6,000	7,500
3,640	4,500	4,950	6,000	1,625	2,000	3,000	4,500	5,600
41,000	52,600	63,000	74,500	15,200	18,700	32,200	53,600	73,800
5,900	7,800	9,800	11,700	2,100	2,600	4,700	7,800	10,400
$157,980	$203,900	$243,540	$277,140	$67,655	$83,550	$143,375	$221,145	$285,290

of this impregnation (10 pounds per cubic foot) is about $0.335 per tie.

5. Rueping process. A partial cell treatment. Wood seasoned in the open or by steaming, sometimes both, is subjected to a vacuum and then to an air pressure of 80 to 100 pounds per square inch. Without releasing the air pressure, which fills all the wood fibres with compressed air, the retorts are filled with creosote and the pressure is gradually increased to 100 to 150 pounds per square inch. About 10 to 12 pounds of creosote per cubic foot enter the wood under this pressure. The pressure is then released, the oil drained off and a vacuum again produced. The surplus oil is forced out of the wood, leaving the wood fibres impregnated with about 4 to 6 pounds of creosote per cubic foot. The time of treatment of thoroughly air-seasoned ties is about 4 hours 20 minutes. The cost, for an impregnation of 6 pounds per cubic foot, is about $0.225 per tie.

6. Lowry process. Another partial cell treatment. Air seasoned wood is placed in retorts and submerged in creosote. The pores and cells are saturated with 10 to 12 pounds of creosote per cubic foot by forcing in additional creosote to a pressure of about 180 pounds per square inch. The retort is then drained and the wood subjected to a vacuum for 1½ to 2 hours. The final impregnation is about 4 to 6 pounds per cubic foot. The time of treatment and the cost per tie are about the same as in the Rueping process.

7. Card process. A combined zinc-chloride and creosote process. Air-dried and steamed wood, after being subjected to a vacuum for an hour, is submerged in a hot emulsion of ½ pound zinc chloride and 1½ to 4 pounds creosote per cubic foot. Pressure is applied up to 100 to 150 pounds per square inch. After draining the retort, the surplus emulsion is drawn from the wood by vacuum. To prevent separation of the zinc chloride and the creosote, the emulsion is agitated constantly by means of a centrifugal pump. The final impregnation is about ½ pound zinc chloride and 1½ pounds creosote per cubic foot. The time of treatment varies from 6 hours 25 minutes to 8 hours 25 minutes, according to the duration of the steaming process. The cost is about $0.18 per tie.

The full cell creosote process, though most expensive, is probably considered best for all conditions. It is particularly adapted to the treatment of piling and timber, while the other processes are used most extensively for ties. The absorption process is advocated, on account of its cheapness and simplicity, for small quantities of general work, but it is not a thorough success where absolute control of impregnation is desired. Modern practice favors the partial cell

treatment for ties and the full cell treatment for piling and timber.

The equipment of timber treatment plants will usually comprise: steam boilers; vacuum, general service, pressure, fire, and boiler-feed pumps; air compressors; electric generating plant; feed-water heaters; steel and wood storage tanks; tie, bolster and transfer cars; hoisting engines; electric locomotives; overhead and underground reservoirs; piping and fittings; and steel buildings. The retorts are horizontal cylinders fitted with rails on which cars loaded with the timber to be treated are run. The capacities and costs of fourteen typical treatment plants are given in detail in the accompanying tables.

The treatment of piling, which ranges from 10 to 90 feet long and from 8 to 20 inches in diameter, requires from 10 to 20 pounds of creosote per cubic foot. The cost will be about $0.10 per cubic foot for a 10-pound treatment, and 1 cent per cubic foot additional for each additional pound. The cost of a 10-pound treatment of timber will be about $8 per 1,000 board feet; the cost of each additional pound of creosote will be about $0.75. The cost of Burnettizing timber with ½ pound zinc chloride per cubic foot will be about $4 per 1,000 board feet.

A HYDRAULIC TRANSMISSION GEAR FOR MARINE TURBINES.

A BRIEF DESCRIPTION OF THE FÖTTINGER SPEED REDUCTION AND REVERSING DEVICE.

Engineering.

TWO months ago we devoted some space in these columns to a description of the spur-wheel speed-reduction gear devised by Rear-Admiral George W. Melville and John H. Macalpine for interpolation between the marine steam turbine and the propeller shaft. Another solution of the turbine speed problem of equal interest and promise is described in *Engineering* for November 5, 1909. This is the Föttinger hydraulic transmission system, which has been under test at the works of the Vulcan Company of Stettin, Germany, since the Autumn of 1908, and which has recently been installed in a vessel built especially for the purpose of testing the efficiency of the system in actual service. The detailed description and elaborate illustrations of the apparatus in *Engineering* we are unable to reproduce; the abstract following indicates only the general features of the design and possibilities of the system.

Dr. Föttinger was first attracted to the problem from the electrical side. After several experiments with various arrangements, he designed a differential dynamo in which the armature was mounted on a primary shaft and a magnetic field on a secondary shaft, on which also there was an armature, and outside or alongside of it a stationary magnetic field. This device, while giving a combined efficiency of 87 per cent, was complicated and expensive, and Dr. Föttinger was impelled by the results of subsequent researches to the evolving of a differential water-turbine transmitter, in which the primary water wheel, driven by the steam-turbine shaft, transmitted, with a certain velocity, water through guide blades or directly to a secondary wheel or wheels mounted on the secondary or propeller shaft in the same axial plane. In this way it was found possible to provide for transmission ratios of 3 to 1 up to 12 to 1. By an arrangement of guide blades and buckets it was possible to have on the same shafts a reversing water-turbine transmitter of somewhat similar design.

After fourteen months' trial of the transmitter in the electrical power station of the Vulcan works, the device was installed in a vessel built especially for the purpose of testing its efficiency in actual service. The dimensions of the boat are as follows:

Length over all	96 feet 4.7 inches
Length between perpendiculars	91 feet 0.5 inches
Moulded breadth	14 feet 3.2 inches
Depth	8 feet 0.5 inches
Displacement	76.7 metric tons
Midship section	52.75 square feet
Coefficient of fineness	0.432
Submerged area	931.11 square feet

The vessel was designed for a speed of 12 to 13 knots. The power required is

about 430 indicated horse power, corresponding to about 500 primary horse power of a transmitter. Steam at 17 atmospheres pressure is supplied by one water-tube boiler of the small-tube type to a four-stage Curtis turbine, fitted with a governor to prevent the turbine from running at a higher speed than 1,900 revolutions per minute. The transmitter was fitted immediately abaft the steam turbine, though it may also be fitted before the stern tube at the end of the shafting.

"The transmitter consists of two chambers of cast iron, the after one for driving the propeller shaft ahead at a reduced speed, and the forward one for driving it astern, also at a reduced speed. This arrangement may be altered so far as the disposition of the respective transmitters is concerned. Each of the transmitters is alike in principle. They consist of a primary water-turbine wheel mounted on the primary or steam-turbine shaft, and one or more—in this case two—secondary water turbines mounted on a secondary or propeller shaft, with one or more stationary guide wheels interposed at any place of the circuit. The wheels and blades are of bronze, and the wheels are keyed to the shaft. The series of primary and secondary wheels and guide blades constitute a complete cycle, and the water moves in a constant compact flow, the primary wheels taking the water again immediately from the last secondary wheel; but guide blades may be interposed should this be considered necessary. The water, of course, impinges on the whole circumference of the turbine wheels. The water is given pressure and velocity in the primary wheel, which is coupled to the steam-turbine shaft, and delivers the water, in this case of ahead circuit, directly to the first secondary wheel; in this wheel only part of the energy, especially velocity, is absorbed in driving the propeller shaft. The water then flows through stationary guide blades, which are connected to the casing, and, leaving these blades, passes through the second secondary turbine, which absorbs the remainder of the energy; the water still flows at a certain velocity to the primary wheel. The first, and certainly the second, secondary wheel is reactionary. The blades of the primary water-turbine are curved back, while those in the first secondary water-turbine correspond to ordinary impulse water-wheel blades. The guide-blades are similar to those in reaction water and steam turbines. The blades in the second secondary wheels are nearly radial and in some cases quite radial. The clearances are similar to those in ordinary steam-turbine practice. All spiral casings and connecting tubes to the primary centrifugal pump and secondary turbines are wholly dispensed with. . .

"The medium for driving the transmitter is fresh water, which is satisfactory from the point of view of friction and of density. No difference in efficiency has been noticed, even when large quantities of oil, saline, or other impurities have found their way into the water. The transmitter is supplied with water by the small centrifugal pump driven from the steam turbine through bevel gear upon an extension of the turbine placed at the forward end. This absorbs about 0.5 per cent of the power of the steam turbine. The pump maintains a constant, but slight, pressure in the pipes between the supply tank and the manœuvring valve, which consists of several chambers within a casing. The pump serves for supplying the water when manœuvring, and for replacing the leakage. It is beneath the water level in the feed tank, so that there is always a suitable column to ensure efficient suction. Normally there is always sufficient pressure of water in the valve chambers to enable the water supply for the transmitters to be withdrawn from one or other of the two transmitters, and to pass it to the other."

Reversing is accomplished by an admission valve controlling the flow of water to the admission nozzles or ports in the ahead or astern turbines. On the occasion of a recent trial, the turbine running at 1,600 revolutions and the propeller shaft at about 270 revolutions ahead, the lever for controlling the valve for filling the astern water turbine and emptying the ahead water turbine was thrown over, and in 19 seconds the shaft was running at 250 revolutions astern.

The return to full speed ahead from full speed astern was accomplished in even less time.

The transmission efficiency in this test is shown in the article under review in three diagrams, showing, respectively, the progressive power curve, the efficiency curve at progressive powers, and the results of a brake test at 1,100 revolutions per minute. The efficiency curve at progressive powers shows that the efficiency of transmission in the ratio of 4.5 to 1 rises very rapidly. From 78 per cent. at 600 revolutions of the primary shaft, it advances steadily until 1,250 revolutions are reached, after which the efficiency remains constant at 83 per cent. In the third diagram mentioned above, the curve of the primary horse power shows nearly constant power rate for a very wide range of secondary speed. Between transmission ratios of 5 and 3.7 it exceeds 80 per cent and between 6 and 3.5 it exceeds 75 per cent. In case regulating devices as in modern water turbines should be employed the range of highest efficiency will be still greater. The efficiency may be further increased by utilizing the heat generated by friction in the water turbines to raise the temperature of the boiler feed water. It is estimated that about 15 per cent of the energy supplied to the transmitter is transformed by the friction of the water and other losses into heat. The temperature of the boiler feed may be raised 36 to 45 degrees F. by using the feed water for filling the turbines before it enters the boilers.

"The system has very considerable potentialities. It enables the turbine to be overloaded without increasing the revolutions of the turbine, and secures for a slow running propeller all the advantages of the turbine, with its high efficiency and its freedom from oil in the condensed water, a very important factor in marine installations. The introduction of the reversing system permits of the continuous use of the economical high-speed ahead turbine, irrespective of ahead or astern steaming; and this, in ships which are frequently reversed, is an important factor. Moreover, the same power is available for going astern as for going ahead, while the adoption of large-diameter and large-area propellers gives greater propulsive power in reversing and manœuvring. In the event of any fracture of the shaft or the propeller involving over-racing, the transmitter acts itself as a relief governor to the turbine."

As regards the application of the system to torpedo craft, there are no smaller potentialities, as in service their turbines will require to be often manipulated for manœuvres. Besides improving the manœuvring qualities, however, the installation of the Föttinger transmitter reduces the space requirements of the propelling machinery. Comparative designs of torpedo-craft turbine installations, with and without the Föttinger apparatus, plans of which are shown in the article under review, show the following data:

	Without Transmitter	With Transmitter
Horse power of turbines	3,700	3,700
Turbine speed, r. p. m.	800	2,200
Propeller speed, r. p. m.	800	480
Over-all length of each turbine unit, metres	4.15	3.87
Total weight of machinery	18.3	14.6
Saving in length, per cent		6.7
Saving in weight, per cent		20

The saving in weight is reduced to about 10 per cent when the heavier shafting and propellers are included.

We summarize also similar comparative designs for battleship installations. The typical turbine installation without the Föttinger apparatus taken as an example in this case includes on each of the three shafts, a high-pressure, a low-pressure, and an astern turbine, the units being independent and in separate watertight compartments, with a condenser associated with each set. The auxiliary machinery is, of course, identical in the two cases.

	Without Transmitter	With Transmitter
Total brake horse power	30,000	20,000
Turbine speed, r. p. m.	275	720
Propeller speed, r. p. m.	275	125
Total length of machinery, metres	15.6	12
Total area machinery, sq. metres	312	240
Total weight of turbines, tons	592	376
Saving in length, per cent		21
Saving in area, per cent		23
Saving in weight, per cent		36

The net saving in weight when the heavier shafting and propellers are taken into account is about 17 per cent.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING..... 605
ELECTRICAL ENGINEERING..... 616
INDUSTRIAL ECONOMY..... 620
MARINE AND NAVAL ENGINEERING..... 622
MECHANICAL ENGINEERING..... 624
MINING AND METALLURGY..... 637
RAILWAY ENGINEERING..... 645
STREET AND ELECTRIC RAILWAYS..... 648

CIVIL ENGINEERING.

BRIDGES.

Abutments.

Removing and Rebuilding a Bridge Abutment. Paul Sheldon. Illustrated description of work on the Laurel Street bridge, Hartford, Conn. 1000 w. Eng Rec—Nov. 6, 1909. No. 9141.

Arches.

See also Masonry, and Reinforced Concrete, under BRIDGES.

Bascule.

Erecting Vertically a Long Rolling Lift Bridge. Illustrated description of work at Providence, R. I., for the N. Y., N. H. & H. R. R. 1600 w. Eng Rec—Nov. 20, 1909. No. 9429.

An Artistic Bascule Bridge at Copenhagen, Denmark. C. Van Langendonck. Illustration and brief description of a bridge of the double-leaf bascule type, constructed on ornamental lines. 1200 w. Munic Engng—Nov., 1909. No. 9220 C.

Bascule Bridge over the Canal at the Livorno Naval Station (Ponte apribile sul Canale navigabile detto "della Foce" nella Stazione marittima di Livorno). V. Luz-

We supply copies of these articles. See page 650.

zatto. Describes a bridge of the single-leaf type. Ills. 2800 w. Ing Ferro—Oct. 16, 1909. No. 9554 D.

Blackfriars.

Blackfriars Bridge Tramway and Subway. Illustrated detailed description of the bridge widening, construction of electric tramways, and a subway for foot passengers. 2500 w. Tram & Ry Wld—Nov. 4, 1909. No. 9381 B.

Cantilever.

Transport Across Sydney Harbor. Gives maps and illustrations of the proposed cantilever bridge, and proposed tunnel for railway under harbor, discussing the situation. 2000 w. Engng—Nov. 19, 1909. No. 9685 A.

Concrete.

The Availability of Concrete for Bridges: Its Cost and Durability. Henry A. Quimby. Brief discussion of its applicability, with suggestions for its economical use. 1200 w. Pro Nat Assn of Cement Users—1909. No. 9370 N.

Culverts.

See Locks, under WATERWAYS AND HARBORS.

Design.

Impact Stresses. E. A. Stone. Discusses methods for calculating the impact stresses in bridges, illustrating by two examples. 2000 w. Can Soc of Civ Engrs—Oct. 14, 1909. No. 9213 N.

Inspection.

Inspection of Bridges and Buildings. From a committee report to the American Ry. Bridge & Building Assn. 1000 w. R R Age Gaz—Oct. 29, 1909. No. 8992.

Lift Bridges.

An Electrically Worked Lifting Bridge. Illustrated description of a bridge recently constructed over the Union Canal, at Edinburgh. 400 w. Engr, Lond—Nov. 12, 1909. No. 9480 A.

Masonry.

A Large Masonry Arch Bridge in Austria. Description taken from an article by Rudolf Jaussner in the *Zeit.* of the Austrian Soc. of Engrs. & Archts. Ills. 1700 w. Eng Rec—Nov. 27, 1909. No. 9622

The Masonry Arch Bridge over the Isonzo River at Salcano (Die gewölbte Brücke uber den Isonzofluss bei Salcano). Rudolf Jaussner. Illustrated description of this bridge in Austria. 2800 w. Zeitschr d Oest Ing u Arch Ver—Oct. 29, 1909. No. 9708 D.

See also Viaducts, under BRIDGES.

Piers.

The Pneumatic Founding of Pier No. 6, Banas River Bridge, Nagda-Muttra State Railway. Victor Bayley. Illustrated description of the method adopted for the founding of a pier in India on irregular stepped rock formation. 2500 w. Inst of Civ Engrs—No. 3790. No. 9748 N.

Reconstruction.

Weak Points in Old Railway Bridges. Notes from a paper by M. L. Byers. Discussion of how tracks and bridges may be strengthened to carry high-speed trains. 1200 w. Eng News—Nov. 18, 1909. No. 9401.

Strengthening the Bridges with a View to Increasing the Speed of Trains. (Question II, Littera B, for discussion at 8th session of the Railway Congress). Pierre A. Zahariade. Report (No. 2) for Bulgaria, Rumania, Servia and Turkey. Drawings and photographic views. 6500 w. Bul Int Ry Cong—Oct., 1909. No. 9384 G.

Reinforced Concrete.

Concrete Truss Bridge: The First in Canada. Frank Barber. Illustrated description of a recently completed bridge in Ontario—a seven panelled parabolic bowstring truss. 1400 w. Can Engr—Nov. 19, 1909. No. 9437.

The Linda Vista Bridge: A Reinforced-Concrete Trestle, Pasadena, Cal. Illustrated description of a viaduct of six girder spans resting on five tower bents and abutting on the ends on the bank of the valley. 1200 w. Eng News—Nov. 18, 1909. No. 9396.

The Three-Hinged Reinforced-Concrete Arch Across the Vermillion River, Wakeman, O. Description as given by Wilbur J. Watson, in the Pro. of the Ohio Engng. Soc. of an economical long-span highway bridge. 600 w. Eng News—Nov. 18, 1909. No. 9405.

The Design of the Broadway or Sparkman St. Bridge, Nashville, Tenn. Description of the design and methods used in constructing a bridge of combined reinforced-concrete trestles and three steel deck spans. Ills. 5800 w. Eng News—Nov. 25, 1909. No. 9661.

Special Track Elevation Bridges in Chicago. Special reinforced-concrete bridges for street subway openings are illustrated and described. 2000 w. Eng Rec—Nov. 13, 1909. No. 9286.

Ferro-Concrete Bridge Over the River Wansbeck. Illustrated description of a new bridge near North Seaton, England. 800 w. Engr, Lond—Oct. 29, 1909. No. 9185 A.

See also Viaducts, under BRIDGES.

Replacement.

Notes on the Replacing of the Superstructure of the Harlem Ship Canal Bridge. Horace J. Howe. Describes the removal of the old superstructure to a new site and the substitution of a new structure of increased capacity. Also notes on similar work. 7500 w. Pro Am Soc of Civ Engrs—Nov., 1909. No. 9773 E.

Steel.

The Erection of the Webster-Donora Bridge. Illustrates and describes the

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erection of a heavy highway truss span bridge across the Monongahela River. 2500 w. Eng Rec—Nov. 27, 1909. No. 9623.

Highway Bridge Over the Miami River at Elizabethtown, Ohio. H. G. Tyrrell. Brief illustrated description of the longest simple truss span bridge known. 700 w. Can Engr—Nov. 5, 1909. No. 9154.

The River Spans of the St. Louis Municipal Bridge. A double-deck, double-track, railroad and highway structure, about 5,400 feet long, crossing the Mississippi River, is illustrated and described. Also editorial. 2500 w. Eng Rec—Oct. 30, 1909. No. 8972.

Road-Bridges Over the Nile at Cairo. Arthur James Knowles. Illustrated description of three road bridges recently constructed. The main bridge has 14 piers consisting of steel and cast-iron cylinders, and a swing span of the balanced cantilever type. 6500 w. Inst of Civ Engrs—No. 3786. No. 9749 N.

See also Reinforced Concrete, and Replacement, under BRIDGES.

Viaducts.

Reinforced Concrete Viaduct at Rotterdam. E. Ommeganck. Illustrated description of a viaduct of 5300-ft., recently completed. 1200 w. R R Age Gaz—Nov. 26, 1909. No. 9645.

The Assopos Viaduct, Greece. Illustrated description of this viaduct on the Chemins de fer Helleniques, and the method of erection. 2000 w. Eng News—Nov. 4, 1909. No. 9072.

The Wiesen Viaduct on the Davos-Filisur Railway, Switzerland (Le Viaduc de Wiesen sur la Ligne de Davos à Filisur, Haute-Engadine). A masonry arch bridge 2000 metres long. Plate. Ills. 1600 w. Génie Civil—Oct. 16, 1909. No. 9539 D.

CONSTRUCTION.

Arcades.

The Friedrichstrasse Arcade, Berlin (Le Passage couvert de la Friedrichstrasse, à Berlin). Illustrated description. Plate. 3500 w. Génie Civil—Oct. 9, 1909. No. 9537 D.

Coaling Plants.

30-Ton Hydraulic Coaling-Tip. Plate and description of a large capacity coaling-tip recently erectel at the South Dock, Swansea. 1000 w. Engng—Nov. 19, 1909. No. 9689 A.

Coal Pockets.

Coke Storage in the Moosach Gas Works, Munich (Die Koksförderanlage im Gaswerk Moosach der Gasanstalt München). G. Eichbauer. Describes the reinforced-concrete structure for the coal pockets and the handling plant. Ills. 2500 w. Beton u Eisen—Oct. 8, 1909. No. 9713 F.

Columns.

Columns and Struts. Considers formulæ for determining the value of the crippling loads in the present number. 1500 w. Prac Engr—Oct. 22, 1909. Serial. 1st part. No. 9103 A.

Concrete.

Experiments on Conveying Concrete Through Pipes Under Air Pressure. J. W. Buzzell and William H. Larkin, Jr. An illustrated account of experiments made mainly to determine the amount of power needed to convey concrete through pipes of various sizes. 1000 w. Eng News—Nov. 25, 1909. No. 9663.

"New Art" Influences in the Design of Concrete Houses in Europe. Charles W. Wisch. Illustrated article showing the development in cement architecture in Europe. 1200 w. Cement Age—Nov., 1909. No. 9603.

The Construction and Cost of Small Concrete Houses. C. R. Knapp. Information concerning cost and advantages in use of concrete for small dwellings, stables, garages, etc. 1500 w. Pro Nat Assn of Cement Users—1909. No. 9368 N.

Concrete Applied to Dwelling House Construction. Ross F. Tucker. Short paper on the application of solid wall construction to dwelling-house work. 1000 w. Pro Nat Assn of Cement Users—1909. No. 9365 N.

Monolithic Concrete Wall Buildings—Methods, Construction, and Cost. Robert Aiken. Information concerning the use of concrete for structures, its practical applications, cost, etc. Ills. 3000 w. Pro Nat Assn of Cement Users—1909. No. 9363 N.

Concrete Forms for Elevated Railway Construction. Illustrates and describes some of the forms used for the Arborway section of the Forest Hills extension of the Boston Elevated Railway. 2000 w. Eng Rec—Nov. 13, 1909. No. 9288.

See also Waterproofing, under CONSTRUCTION; Drainage, under MUNICIPAL; and Conduits, and Water Towers, under WATER SUPPLY.

Concrete Blocks.

Something New in Concrete Block Making. M. H. Hunting. Illustrated description of a machine that makes 40000 enameled concrete blocks in ten hours. 800 w. Sci Am—Nov. 20, 1909. No. 9421.

Contractors' Plants.

The New York Tunnel Extension of the Pennsylvania Railroad. Contractors' Plant for East River Tunnels. Henry Japp. Illustrated detailed description of the general plant used. 24500 w. Pro Am Soc of Civ Engrs—Nov., 1909. No. 9772 E.

Contracts.

Contracts, with Special Relation to

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Structural Steel Work. A discussion. 14500 w. Pro Engrs' Soc of W Penn—Oct., 1909. No. 9332 D.

Domes.

America's Largest Dome. Illustrated brief description of the dome of the Cathedral of St. John the Divine, in New York, which was erected without scaffolding or falsework support. 800 w. Sci Am Sup—Oct. 30, 1909. No. 8964.

Erecting a Large Dome Without Falsework. Illustrates methods used in erecting the dome of the Cathedral of St. John the Divine, New York City. 2500 w. Eng Rec—Nov. 6, 1909. No. 9140.

Earth Pressures.

See Retaining Walls, under CONSTRUCTION.

Earthquakes.

Periodical Deformations of the Earth's Crust (Le Deformazioni periodiche della Crosta terrestre). Luigi Figari. A contribution to the theory of the causes of earthquakes. Ills. Serial. 1st part. 7000 w. Ann. d. Soc d Ing e d Arch Ital—Oct. 1, 1909. No. 9545 F.

Damages to Buildings in the Calabrian Earthquake of December 28, 1908 (Note sui Danni prodotti ai Fabbricati della Citta di Reggio Calabria dal Terremoto del 28 Dicembre 1908). Achille Somma. Reviews the general conclusions to be drawn from the nature of the damages. Ills. 3500 w. Ann d Soc d Ing e d Arch Ital—Oct. 15, 1909. No. 9547 F.

Impressions of a Technical Survivor of the Catastrophe of December 28, 1908 (La Catastrofe del 28 Dicembre 1908—Impressioni di un tecnico Superstite). Pietro Interdonato. Discusses the behavior of the structures in Messina during the shock and draws conclusions as to safe construction for earthquake countries. 3000 w. Ann d Soc d Ing e d Arch Ital—Oct. 15, 1909. No. 9548 F.

Impressions of the Milan Competition on Earthquake Construction. Impressioni sul Concorso per Costruzione antisismiche di Milano). Luigi Novelli. A review and discussion of the suggestions received. 5000 w. Ing Ferro—Oct. 16, 1909. No. 9555 D.

A Bibliography of Recent Publications on Earthquake Construction (Appunti Bibliografici di Edilizia sismica). Alberto Pacchioni. Lists publications during 1909. 2500 w. Ann d Soc d Ing e d Arch Ital—Oct. 15, 1909. No. 9549 F.

Excavation.

Low Cost of Excavation with Fresno Scrapers. Walter N. Frickstad. A report of records made. Ills. 2000 w. Engng-Con—Nov. 3, 1909. No. 9066.

Rules for Estimating the Cost of Excavating Earth with Fresno Scrapers. Gives method of estimating, illustrating by examples. 1800 w. Engng-Con—Nov. 24, 1909. No. 9659.

Transportation of Rock on Sleds During the Summer in the Construction of the New Alpine Railways (Steinförderung auf Schlitten—im Sommer—beim Baue der neuen Alpenbahnen). Hans Raschka. Describes the sleds and the roll way over which they were drawn. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 8, 1909. No. 9706 D.

Fireproof.

Unburnable Homes—Their Artistic and Architectural Possibilities. Benjamin A. Howes, Jr. An illustrated discussion of the artistic use of concrete for residences. 2500 w. Pro Nat Assn of Cement Users—1909. No. 9367 N.

Two Examples of Economical Fireproofing in Schoolhouses. William H. Brainerd. Illustrates and describes the Daniels Grammar School of Malden, and the Bishop Cheverus School, East Boston, Mass. 2000 w. Am Archt—Nov. 17, 1909. (Special No.) No. 9445 F.

Cold-Storage Warehouses as a Fire Hazard. Joseph B. Finnegan. Read before the Am. Soc. of Refrig. Engrs. Discusses the hazards, the structural features, and the protective equipment. 4000 w. Cold Storage & Ice—Nov., 1909. No. 9376 C.

Quincy Market Cold Storage Warehouse, Boston. Illustrated detailed description of a 10-story building as nearly fireproof as present practice makes possible, and embodying the most up-to-date ideas with regard to insulation. 3000 w. Eng Rec—Nov. 13, 1909. No. 9284.

Floors.

Reinforced "Sterile" Floors (Bewehrte Sterildecken). Emil Morgensen. Describes a new type of floor construction designed for a special purpose in Denmark. Ills. 2000 w. Beton u Eisen—Oct. 30, 1909. No. 9715 F.

Foundations.

The Shield Method Applied to Sinking Building Footings; Chicago & Northwestern Terminal, Chicago. Illustrated description of the conditions and the method used. 1000 w. Eng News—Nov. 18, 1909. No. 9403.

Settlement of an Old Pile Foundation Causes Sudden Alarm. A statement of facts relating to the foundation settlement of the New York County Criminal Court building, in New York City. 1600 w. Eng News—Nov. 11, 1909. No. 9254.

Concreting Structural Foundations. F. A. Lart. Discusses the solidification of natural soil by cement grouting. 5500 w. Cassier's Mag—Nov., 1909. No. 9310 B.

Pneumatic Foundations of the Emigrant Bank Building. A detailed account of methods of sinking caissons and constructing foundations for a new building without interrupting business in a bank occupying a part of the site. 3500 w. Eng Rec—Nov. 6, 1909. No. 9148.

We supply copies of these articles. See page 650.

The Calculation of Foundations for Gable Walls (Berechnung von Giebelpfeilerfundamenten). Heinrich Becher. Mathematical. Ills. 2000 w. Beton u Eisen—Oct. 8, 1909. No. 9710 F.

Grain Elevators.

See Grain Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Grouting.

Some French Methods and Machines for Grouting. Abstract translation of an article by Mr. Suquet, in *Ann. des Ponts et Chaussées.* Illustrated description. 1600 w. Eng Rec—Oct. 30, 1909. No. 8975.

The Pumping of Cement Grout Into Masonry in the Metropolitan Railway, Paris. Abstract translation of an article by Mr. Suquet, in *Ann. des Ponts et Chaussées.* Illustrated description of apparatus used and the composition of the grout. 1200 w. Eng News—Nov. 25, 1909. No. 9665.

See also Tunnel Lining, under CONSTRUCTION.

Masonry.

Stability of Masonry Against Overturning. W. C. Johnson. Brief consideration of ways of determining the factor of safety, showing the error under certain conditions of the graphic method. 1000 w. Technograph—1909. No. 9764 D.

Pile Driving.

The Bucyrus Locomotive Pile Driver. Walter Ferris. Illustrated description of this railway pile driver and its work. 2500 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9347 F.

Driving Piles by Simple Loading (Beitrag zur Beurteilung der Wirkung ruhender Lasten auf Rostpfähle). E. v. Willmann. A discussion of the possibility of driving reinforced-concrete piles by a static load instead of by blows of a pile driver. Ills. 2200 w. Beton u Eisen—Oct. 8, 1909. No. 9712 F.

Piling.

Concrete Piles—Forms, Advantages and Cost as Compared with Wooden Piles. C. W. Gaylord. An illustrated discussion of foundation piles, discussing the various forms, and the comparative cost of wood and concrete piling. 3500 w. Pro Nat Assn of Cement Users—1909. No. 9373 N.

Large Concrete Pillars for a Difficult Substructure. Explains Conditions at Perth Amboy, N. J., where the work was carried out, where "compressol" pillars were used for foundations. 1800 w. Eng Rec—Nov. 27, 1909. No. 9628.

A Review of Recent Literature on Piling (Rückblick auf neuere Arbeiten in der Pfahlstatik). Ottokar Stern. With a reply by Joh. Basta to a criticism of his paper. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 16, 1909. No. 9701 D.

Record Systems.

See Filing Systems, under INDUSTRIAL ECONOMY.

Regulations.

Regulations adopted by the Swiss Commission on Reinforced-Concrete Construction (Règlement sur les Constructions en Béton armé établi par la Commission Suisse du Béton armé). Gives the full text of the regulations. Serial. 1st part. 1800 w. Bul Tech d l Suisse Romande—Oct. 10, 1909. No. 9524 D.

Reinforced Concrete.

A Note on the Theory of the Vierendeel Beam (Ein Beitrag zur Theorie der Vierendeelträger). P. M. Frandsen. Mathematical discussion. Ills. Serial, 1st part. 2000 w. Beton u Eisen—Oct. 30, 1909. No. 9716 F.

Reinforced Concrete Construction (Le Modalita di Collaudo delle Opera in Cemento armato). Cherubino Pinciroli. Examines the bases for the estimation of the excellence of reinforced concrete structures. 5100 w. Monit Tech—Oct. 30, 1909. No. 9550 D.

Conservation of Plane Section in Concrete Beams. Roland P. Davis. An account of experimental investigations carried out in the laboratory of Cornell University to determine the effect of varying the percentage of reinforcement. 2500 w. Eng Rec—Nov. 6, 1909. No. 9143.

Evolution of Reinforcement for Concrete. Harry F. Porter. A review of the development of steel reinforcement, describing especially the unit system. Ills. 3300 w. Pro Nat Assn of Cement Users—1909. No. 9364 N.

Progress in the Use of Metal Forms with Comparative Costs. W. L. Caldwell. Brief account of recent ideas and the advantages claimed for the metal over the wood forms. 2500 w. Pro Nat Assn of Cement Users—1909. No. 9374 N.

Rigid Frames in Reinforced Concrete Construction (Der steife Rahmen in Eisenbetonbau). Emil Reich. Mathematical and theoretical. 3500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 30, 1909. No. 9703 D.

Comparative Cost of Reinforced Concrete Buildings. Emile G. Perrot. Brief article comparing the cost with steel construction fireproofed. Ills. 2000 w. Pro Nat Assn of Cement Users—1909. No. 9362 N.

The Utilization of Over 6,000,000 Cubic Metres of Concrete in the Construction of the Panama Canal (Die Verwendung von über 6,000,000 m³ Beton beim Bau des Panamakanals). H. Prime Kieffer. Describes the applications and illustrates various parts of the work. 5000 w. Beton u Eisen—Oct. 8, 1909. No. 9711 F.

The Cupola over the Kitchen of the Frankfurt Hospital (Die Kuppel über der Dampfkochküche des städtischen Krank-

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enhauses zu Frankfurt a. M.). Arthur Laufer. Mathematical discussion of the design. Ills. Serial. 1st part. 2000 w. Beton u Eisen—Oct. 30, 1909. No. 9714 F.

See also Regulations, and Retaining Walls, under CONSTRUCTION; Sewers, under MUNICIPAL; Piers, under WATERWAYS AND HARBORS; and Subways, under STREET AND ELECTRIC RAILWAYS.

Retaining Walls.

Reinforced Concrete Retaining Walls. A. E. Lindau. Shows the advantage of first cost, maintenance and reliability. Discussion. Ills. 3000 w. Pro Nat Assn of Cement Users—1909. No. 9371 N.

Tables for the Determination of Earth Pressures on Retaining Walls. C. K. Mohler. Presents a table giving constants to be used in determining earth pressures on retaining walls, with explanation. 1200 w. Eng News—Nov. 25, 1909. No. 9668.

School Buildings.

Consideration in School House Design. A. D. F. Hamlin. Discusses the chief elements of the schoolhouse problem, summing up the points of modern American practice. Ills. 2500 w. Am Archt —Nov. 17, 1909. Serial. 1st part. (Special No.) No. 9444 F.

Splices.

Splices for I-Beams and Channels. A. L. Campbell. Supplement, illustrations and calculations of splices for such work. 2200 w. Mach, N Y—Nov., 1909. No. 9086 C.

Stacks.

Calculations for Determining the Size of Plates for a Self-Supporting Steel Stack Base. J. N. Heltzel. Gives calculations essential in making the estimates for ordering the plates and laying them out. 800 w. Boiler Maker—Nov., 1909. No. 9121.

Steel.

See Contracts, and Splices, under CONSTRUCTION.

Stone Crushing.

The Rock Crushing Plant at Porto Bello for the Panama Canal. Illustrated detailed description of the plant for quarrying, crushing and transporting stone to Gatun. 3500 w. Eng Rec—Nov. 20, 1909. No. 9428.

Time Keeping.

A Method of Keeping Time on Scattered Jobs Contracted for on a Commission Basis. Leonard Lytle. Describes methods used by a construction company in Sioux City, Ia. 1200 w. Engng-Con —Nov. 24, 1909. No. 9660.

Tunnel Lining.

Lining and Grouting a French Railway Tunnel in Water-Bearing Material. An illustrated account of this work as described by E. Nivert, in the *Rev. Gen. des Chem. de Fer.* 1500 w. Eng News—Nov. 25, 1909. No. 9664.

The Re-lining of a Portion of Cwm Cerwyn Tunnel on the Port Talbot Railway. William Cleaver. Illustrated description of work presenting novel features in both its design and execution. A portion of the tunnel was re-lined with cast-iron segments without interference with traffic. 3500 w. Inst of Civ Engrs —No. 3783. No. 9750 N.

Tunnels.

Some Detail Tunnel Costs in Tunnel No. 7 of the Los Angeles Aqueduct. C. H. Richards. 2000 w. Eng News—Nov. 18, 1909. No. 9399.

A World's Record in Tunnel Driving. Burt A. Heinly. An account of the record made by the engineers of the Los Angeles aqueduct. Ills. 1000 w. Min & Sci Pr—Oct. 30, 1909. No. 9116.

The Loetschberg Tunnel Through the Bernese Alps. Dr. Alfred Gradenwitz. An illustrated account of the construction and some of the dangers of the work. 2000 w. Sci Am Sup—Nov. 6, 1909. No. 9082.

Tunnelling by the Freezing Process on the Metropolitan Railway of Paris (La Congélation du Sol dans les Travaux du Métropolitain). Describes the use of the freezing process in driving the tunnel under the Seine. Ills. 5000 w. Tech Mod—Oct., 1909. No. 9527 D.

See also Cantilever, under BRIDGES; Contractors Plants, and Grouting, under CONSTRUCTION; and Tunnels, under MINING AND METALLURGY, MINING.

Underpinning.

Underpinning Buildings Near Excavations, New York City. Describes conditions met in constructing the Bridge Loop subway, and the Hudson Tunnel through Cortlandt Street. 1500 w. Eng Rec—Nov. 27, 1909. No. 9621.

Waterproofing.

Making Concrete Waterproof. Ira O. Baker. Gives results of recent experiments with alum and soap waterproofing compound, and the effect of water-repelling compound. 2500 w. Technograph—1909. No. 9768 D.

Review of Methods of Waterproofing Concrete Structures. C. G. Derick. A review of general practice and of new methods coming into use. 2800 w. Technograph—1909. No. 9769 D.

Waterproofing—Various Applications and Comparative Costs. T. Hugh Boorman. Considers briefly the hot, cold, and dry methods. 4000 w. Pro Nat Assn of Cement Users—1909. No. 9366 N.

Waterproofing a Shaft of the Blue Island Ave. Water Tunnel at Chicago. Describes the method of sinking and waterproofing this tunnel shaft. Ills. 2000 w. Eng News—Nov. 11, 1909. No. 9250.

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MATERIALS OF CONSTRUCTION.

Asphalt.

Some Comments on Asphaltic Specifications. H. Tipper. Criticizes the present method of specifying, and some of the tests required, and gives proposed specifications. 2000 w. Can Engr—Nov. 12, 1909. No. 9303.

Cement.

The Rate of Increase in Strength of Cement. Reprint from a report by Clifford Richardson giving opinions of a number of experts, and discussing the subject generally. 2000 w. Eng Rec—Oct. 30, 1909. No. 8971.

Concrete.

Concrete—Its Constituent Materials. Russell S. Greenman. A non-technical discussion of facts relating to the constituent materials. 5000 w. Barge Canal Bul—Nov., 1909. No. 9758 N.

The Compressive Strength of Coke Concrete. John M. Lewis. An account of experiments made at Cornell University to determine the strength of concrete made with coke instead of stone. Ills. 1200 w. Eng Rec—Oct. 30, 1909. No. 8968.

See also same title, under BRIDGES; and Subways, under STREET AND ELECTRIC RAILWAYS.

Masonry.

The Effect of Temperature Changes on Masonry (Die Wirkung des Temperaturwechsels auf Mauerwerk). P. Ziegler. A discussion of Charles S. Gowen's paper on this subject, A. S. C. E., 1908. Ills. Serial. 1st part. 2000 w. Beton u Eisen—Oct. 8, 1909. No. 9717 F.

Mortar.

Observations on Materials for Binding Mortar. Anton Hambloch. On the characteristics of the substances used and the conditions under which they gradually harden. 1000 w. Engr, Lond—Oct. 29, 1909. No. 9184 A.

Paints.

Paints for Metal with Comments on the Use of Compressed Air for Painting and Cleaning. Report by George L. Fowler to the Am. Bridge & Building Assn. Shows that the use of air defeats the purpose of the painting. 1800 w. Engng-Con—Oct. 27, 1909. No. 9016.

Reinforced Concrete.

Experiments on the Strength Properties of Reinforced-Concrete Beams. William Charles Popplewell. Describes experiments at the laboratory of the Manchester School of Technology, to compare the behavior, when tested to destruction, of beams only varying in the arrangement of the reinforcement. 4000 w. Inst of Civ Engrs—No. 3843. No. 9752 N.

The Schüle Tests on Reinforced Concrete Beams and Columns (Versuche Schüles mit Eisenbetonbalken und-Säulen). M. R. v. Thullie. Report of tests made for the Swiss reinforced-concrete commission. 2000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 1, 1909. No. 9705 D.

Recent Tests on Reinforced Concrete Beams (Neue Versuche an Betoneisenbalken). Alfons Leon. A review of a number of tests and a summing up of their results. Ills. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 2, 1909. No. 9700 D.

See also Subways, under STREET AND ELECTRIC RAILWAYS.

Steel.

An Investigation of the Resistance of Channel Beams (Versuche über die tatsächliche Widerstandsfähigkeit von Balken mit [-förmigem Querschnitt). C. Bach. Reports results of tests on beams of various dimensions. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1909. No. 9737 D.

A New Beam Profile Evolved by the Italian State Railways (Un nuovo Profilo di Travi in Ferro studiato dall'Amministrazione delle Ferrovie dello Stato e Laminato presso lo Stabilimento della Societa siderurgica di Savona). Ills. 3500 w. Ing Ferro—Oct. 1, 1909. No. 9553 D.

Terra Cotta.

Terra Cotta: Its Character and Construction. Charles U. Thrall. An illustrated series of articles giving information concerning this material and its uses. 1700 w. Br Build—Oct., 1909. Serial. 1st part. No. 9025 D.

MEASUREMENT.

Bitumen Testing.

Testing Bitumens for Pavements. Illustrated description of the method due to A. W. Dow and the machine used. 1500 w. Sci Am—Nov. 6, 1909. No. 9081.

Cement Testing.

The Importance and Cost of Cement Testing. W. Purves Taylor. Showing the importance of having tests made by trained men and with the greatest care. 1200 w. Pro Nat Assn of Cement Users—1909. No. 9369 N.

Portland Cement: the Immediate Immersion or "Cold Plunge" Test for Soundness. Arthur Charles Davis. Describes results obtained in an effort to ascertain the cause of cements cracking in the cold plunge test. 2000 w. Inst of Civ Engrs—No. 3829. No. 9751 N.

Laboratories.

The Illinois Engineering Experiment Station. L. P. Breckenridge. Considers its organization, plan and scope, influence, etc. 3000 w. Technograph—1909. No. 9763 D.

Levelling.

A Novel Leveling Apparatus for Use in

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a Sewer. G. S. Coleman. Illustrated description of a device for holding a level rod in an inaccessible sewer. 1000 w. Eng News—Oct. 28, 1909. No. 8984.

Magnetic Surveys.

First Magnetic Results Obtained on the "Carnegie" in the North Atlantic. L. A. Bauer and W. J. Peters. An account of tests at Gardiner's Bay, Long Island, N.Y., to determine whether non-magnetic conditions had been secured. 3000 w. Nature —Oct. 28, 1909. No. 9160 A.

Surveying.

Surveying Conveniences. E. N. Millen. Describes an outfit for a hilly region where saving in weight is important. 1200 w. Eng News—Oct. 28, 1909. No. 8980.

MUNICIPAL.

Drainage.

Methods of Providing for Storm Drainage at Street Intersections, with Some Costs of Catch Basin Construction. J. H. Weatherford. Read before the Am. Soc. of Munic. Imp. Discusses types of drains and the types that interfere least with vehicle or foot traffic. 2000 w. Engng-Con—Nov. 17, 1909. No. 9390.

Molded Concrete Pipe and Storm Drains, Newark, New Jersey. Illustrates and describes types of drain and mold for pipe being used in a system of storm water drainage. 1200 w. Eng Rec—Nov. 6, 1909. No. 9144.

The Calumet Drainage Channel of the Chicago Sanitary District. Abstract of a report made by G. M. Wisner on this channel. 3500 w. Eng News—Nov. 18, 1909. No. 9404.

Aberdeen Main-Drainage Works: Girdleness Outfall Scheme. George Robert Graham Conway. Drawings and description of the conditions and the drainage scheme. 10000 w. Inst of Civ Engrs—No. 3721. No. 9747 N.

Pavements.

Paving Practice with Respect to Crowns of Roadway Pavements and Concrete Foundations. George C. Warren. Presented at meeting of Am. Soc. of Munic. Imp. Discusses the tendency to provide too flat crowns, the effect on the durability of the pavement, etc. 4500 w. Engng-Con—Nov. 19, 1909. No. 9202.

Cost and Value of Concrete Pavements. J. H. Chubb. Gives information pertaining to work of this character in the United States and Canada. 4000 w. Pro Nat Assn of Cement Users—1909. No. 9375 N.

Care in the Construction of Vitrified Brick Streets. Will P. Blair. Illustrated detailed instructions for the proper laying of vitrified brick paving. 1800 w. Eng News—Nov. 25, 1909. No. 9667.

Method of Constructing Creosoted Wood Block Pavement at Grand Forks, N. D. Description of the works as given by J. J. Smith, city engineer. 3500 w. Engng-Con—Oct. 27, 1909. No. 9013.

Observations of Asphalt Paving and Some Present Needs. H. Tipper. Read before Am. Soc. of Munic Imp. Discusses methods of construction. 2500 w. Engng-Con—Nov. 17, 1909. No. 9388.

Machine Mixing Asphalt Macadam. Illustrated description of a method of construction used near Paterson, N. J., with cost. 2500 w. Munic Jour & Engr—Nov. 17 1909. No. 9356.

See also Bitumen Testing, under MATERIALS OF CONSTRUCTION.

Refuse Disposal.

Incinerators and Utilization of Waste Heat. E. N. Stacy. Illustrates and describes various types of incinerators, discussing them critically, and matters relating to their management. 3500 w. Minn Engr—Nov., 1909. No. 9776 C.

The Efficiency of Various Methods of Refuse Disposal (Die Wirtschaftlichkeit verschiedener Müllbesoitigungsverfahren). Herr Brandis. Gives results obtained in destructors in various parts of the world. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 16, 1909. No. 9735 D.

Roads.

The Road Surface. W. A. McLean. Read before Ontario Land Surveyors. Some points in road construction are discussed. 2000 w. Can Engr—Nov. 5, 1909. No. 9155.

The Detailed Cost of Constructing a Sand-Gumbo Road in Mississipni County, Missouri. Describes the construction, giving costs. Ill. 600 w. Engng-Con—Oct. 27, 1909. No. 9012.

Methods and Some Costs on the Construction of Chert-Macadam Roads. Edward B. Kay. Abstract of a paper read before the Ala. Good Roads Assn. Describes the construction of these roads in Alabama, giving costs. 1500 w. Engng-Con—Nov. 3, 1909. No. 9067.

Recent Experiences in Bituminous Road Construction. Abstracts of addresses made at the meeting of the Massachusetts Highway Assn. at Boston. 3500 w. Eng Rec—Nov. 20, 1909. No. 9427.

Sanitation.

Education in Municipal Sanitation. H. N. Ogden. On the need of educating the people. 1600 w. Cornell Civ Engr—Nov., 1909. No. 9610 C.

Oriental Sanitary Engineering. C. T. Evannette. Notes on the effect of castes in India, with brief consideration of roads, drainage and sewerage systems. 3000 w. Surveyor—Nov. 12, 1909. Serial. 1st part. No. 9465 A.

Sewage Disposal.

A Discussion of the Fifth Report of the Royal Commission on Sewage Disposal of Great Britain (Betrachtungen zum fünften Bericht der Königlich Englischen Kommission für Abwasserbehandlung). A. Lübbert. 4000 w. Gesundheits-Ing—Oct. 23, 1909. No. 9598 D.

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Some Observations on the Chemistry and Bacteriology of Sewage Purification. David Sommerville. Presents fundamental principles connected with the purification of sewage, showing the changes due to bacterial activity, the effect of chemical and physical conditions, etc. 7500 w. Soc of Engrs—Nov. 5, 1909. No. 9759 N.

Aerial Distribution of Sewage Over Percolating Filters. William Gavin Taylor. A resumé of studies made at Waterbury, Conn., prior to 1909. 12500 w. Eng News—Nov. 11, 1909. No. 9252.

Experimental Investigation of the Sewage Disposal of Ithaca, N. Y. William J. McKee. An investigation with the object of obtaining data on the control and operation of various kinds of auxiliary filters. 2000 w. Cornell Civ Engr—Nov., 1909. No. 9611 C.

Construction of the Baltimore Sewage Disposal Works. First of a series of articles illustrating and describing methods of construction. 2500 w. Eng Rec—Nov. 13, 1909. Serial. 1st part. No. 9285.

Sheffield (Eng.) Sewage Works Extension. An illustrated account of the completion of the first section of a £400,000 scheme. 4000 w. Surveyor—Nov. 5, 1909. No. 9270 A.

The Charlottenburg Sewage Farm and its Economic Returns (Das Charlottenburger Rieselfeld und seine wirtschaftliche Bedeutung). Herr Geissler. Describes the distribution and treatment of the sewage and the agricultural uses of the farm. 4000 w. Gesundheits-Ing—Oct. 30, 1909. No. 9599 D.

Sewers.

Some Tests on the Comparative Resistance to Wear of Different Materials for Sewer Inverts. Edward S. Rankin. Read before the Am. Soc. of Munic. Imp. Reports results of absorption tests. 700 w. Engng-Con—Nov. 17, 1909. No. 9389.

Sizes, Materials and Shapes of Sewers in the City of Hamilton. E. G. Barrow. Illustrates and describes the various forms and materials of sewers, pointing out defects and discussing costs. 1000 w. Can Engr—Oct. 29, 1909. No. 9031.

Some Structural Details and Notes on Construction of a Reinforced Concrete Pipe Sewer. Illustrates and describes details of a sewer under construction at Waukegan, Ill. 1000 w. Engng-Con—Nov. 3, 1909. No. 9065.

Sewer Construction in Stapleton, Staten Island. Describes conditions and work in progress. Ills. 2000 w. Eng Rec—Oct. 30, 1909. No. 8976.

A Concrete and Steel Storm Water Sewer and Some Remarks on Specifications and Designs. Comments on defects in the specifications and criticism of designs. Ills. 3000 w. Engng-Con—Nov. 3, 1909. No. 9068.

Sewer Construction in San Francisco. O. D. Johns. Illustrated description of an intercepting sewer in San Francisco; 6500 feet of reinforced concrete, largely on pile foundations, and 1900 feet of pipe sewers. 2500 w. Eng Rec—Nov. 27, 1909. No. 9625.

Cardiff Western District Main Outfall Sewer. William Harpur. Illustrated account prepared for visiting members of the Incor. Assn. of Munic. & Co. Engrs. 3000 w. Surveyor—Oct. 22, 1909. No. 9104 A.

See also Levelling, under MEASUREMENT.

WATER SUPPLY.

Analysis.

The Interpretation of Chemical Water Analysis. Dr. Hartwig Klut. Information concerning the determining of the hygienic condition of water. 5000 w. Eng Rec—Oct. 30, 1909. No. 8977.

Aqueducts.

The Los Angeles Aqueduct. Burt A. Heinly. An illustrated brief description of the longest aqueduct in the world, discussing the causes of the low cost and rapidity of construction. 3300 w. Munic Engng—Nov., 1909. No. 9219 C.

Conduits.

A Twelve-Mile Concrete Pipe Conduit. Illustrated description of a 36-in. concrete pipe line built in northwestern Colorado 3300 w. Eng Rec—Nov. 6, 1909. No. 9142.

Dams.

Some Observations on the Stability of Dams. J. F. Jackson. Considers the manner of calculating and constructing various types of dams. Discussion. Ills. 5800 w. Jour W Soc of Engrs—Oct., 1909. No. 9337 D.

The Statical Design of Dams (Ueber statische Berechnung von Talsperren). Herr Ramisch. A theoretical discussion of the stability of dams. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 22, 1909. No. 9707 D.

The Standley Lake Dam, Near Denver, Colorado. Illustrated detailed description of one of the highest earthen dams yet built, which will develop a reservoir capacity of 100,000 acre-feet of water. 5500 w. Eng Rec—Nov. 13, 1909. No. 9283.

Filtration.

The Ludlow Filters. Carroll F. Story. Reviews briefly the history of water supply at Springfield, Mass., explaining the conditions, and outlining the design of the filtration plant, and its operation. Discussion. 10000 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9612 F.

The Bernhart Sand Filters, Reading, Pa. Describes the water supply system, and gives illustrated detailed description of the filters and their construction. 2800 w. Eng Rec—Nov. 13, 1909. No. 9289.

Water Purification at Wilmington, Delaware. Describes the six slow sand filters recently constructed and the filtered-water reservoir. Ills. 3000 w. Eng Rec—Nov. 20, 1909. No. 9426.

Torresdale Pumping Plant and Filters. Thomas Wilson. Brief illustrated description of this Philadelphia plant—the largest in the world for purifying drinking water. 3000 w. Power—Nov. 16, 1903. No. 9318.

Indianapolis Water Filtration. Describes a plant using coagulation when necessary, followed by sedimentation. Alum and lime-iron processes are compared, and results and costs given. Ills. 2200 w. Munic Jour and Engr—Nov. 3, 1909. No. 9059.

Fire Protection.

Automatic Sprinkler Systems. Charles L. Hubbard. Illustrates and describes the different systems of piping for automatically extinguishing fires. 3000 w. Met Work—Nov. 20, 1909. No. 9407.

Great Lakes.

The Waters of the Great Lakes. R. B. Dole. A study of the composition, giving analyses. 2500 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9613 F.

Ground Waters.

Underground Water in Crystalline Rocks. Frederick G. Clapp. Presents some facts of value, not generally known, regarding the occurrence of water in granite and similar rocks. Ills. 4500 w. Eng Rec—Nov. 6, 1909. No. 9147.

Holyoke, Mass.

Odors and Tastes in the Water Supply of Holyoke. James L. Tighe. Maps and account of the trouble with the supply. Discussion. 10800 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9617 F.

Irrigation.

Irrigation in Mesopotamia (L'Irrigation de la Mésopotamie). Louis Godard. Outlines the projects of Sir William Willcocks. Ills. 5600 w. Génie Civil—Oct. 16, 1909. No. 9540 D.

The Irrigation of the Plain of Konia, Asia Minor (L'Irrigation de la Plaine de Konia). M. Godard. Reviews the projects of the Turkish Government. Ills. 4400. Ann d Ponts et Chaussées—1909-V. No. 9745 E + F.

See also Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Meters.

See Venturi Meters, and Water, under MECHANICAL ENGINEERING, MEASUREMENT.

Newton, Mass.

The Water Supply System of Newton, Mass. Brief description of the system of supplv from wells, and extensions in progress. 2500 w. Eng Rec—Nov. 20, 1909. No. 9431.

Pollution.

An Investigation of the Passage of Bacteria through the Soil (Untersuchungen über die Durchlässigkeit des Bodens für Bakterien). Fritz Ditthorn and Artur Luerssen. A report of extended tests in Berlin. 4500 w. Gesundheits-Ing—Oct. 9, 1909. No. 9597 D.

Purification.

Disinfection as an Adjunct to Water Purification. H. W. Clark and Stephen deM. Gage. Discusses the various disinfectants used, their efficacy and cost of treatment. Discussion. 7000 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9616 F.

The Poughkeepsie Water Works. Dr. John C. Otis. An illustrated description of the purification system for the treatment of Hudson River water. Discussion. 5500 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9615 F.

Reservoirs.

Haslingden Water Supply. Illustrated description of the Scout Moor high-level reservoir. 1200 w. Surveyor—Nov. 5, 1909. No. 9269 A.

See also Filtration, under WATER SUPPLY.

Waste.

Water Waste Prevention by Adequate Surveys and Inspection. Abstract of report of T. E. Phillips, on an investigation of water waste in Chicago. 3500 w. Engng Con—Oct. 27, 1909. No. 9014.

Water Towers.

A Concrete Water Tower of Interesting Block Construction in Belgium. H. Prime Kieffer. Illustrated description of an interesting construction. 700 w. Cement Age—Nov., 1909. No. 9604.

The Collapse of a Wrought-Iron Stand-Pipe at White Plains, N. Y. An illustrated description of the failure of this stand-pipe on Oct. 20, 1909. 1500 w. Eng News—Oct. 20, 1909. No. 8982.

Water Works.

The Development of the Camaguey Water-Works, Cuba. Henry A. Young. An illustrated description of the design and construction of a tropical plant. 4000 w. Jour N Eng W-Wks Assn—Sept., 1909. No. 9614 F.

Wells.

The Interference of Wells. Frederick G. Clapp. On the mode of occurrence of underground waters, and the conditions under which deep wells affect other wells. 3000 w. Eng News—Nov. 4, 1909. No. 9074.

WATERWAYS AND HARBORS.

Canals.

The New Trollhättan Canal. Map and illustrated account of this new canal between Lake Vänern and the Kattegat. Sweden. 2500 w. Engng—Oct. 29, 1909. No. 9179 A.

We supply copies of these articles. See page 650.

Docks.

Chelsea Municipal Docks, New York. Illustrated description of the steel-concrete docks nearing completion on the North River, and their equipment. 4000 w. Munic Jour & Engr.—Nov. 3, 1909. No. 9058.

The King's Dock, Swansea. Reviews the history of the port and gives an illustrated description of the new works just completed. 3000 w. Engr, Lond—Nov. 19, 1909. Serial. 1st part. No. 9692 A.

Dredging.

Comparison of the Working Costs of the English or New Zealand and Californian Type of Dredges. W. H. Cutten. 2500 w. Min Jour—Nov. 20, 1909. No. 9680 A.

See also Dredges, under MARINE AND NAVAL ENGINEERING.

Ferry Slips.

See Ferry Boats, under MARINE AND NAVAL ENGINEERING.

Flood Protection.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Pétersburg en 1908). A report of the discussion on methods of preventing the inundation of low-lying lands. 11600 w. Ann d Ponts et Chaussées—1909-V. No. 9742 E + F.

Harbors.

Eleventh Industrial Navigation Congress, St. Petersburg, 1908 (XI^e Congrès international de Navigation tenu à Saint-Petersburg en 1908). A report of the discussion on fishery harbors and harbors of refuge for coasting vessels. Ills. 11500 w. Ann d Ponts et Chaussées—1909—V. No. 9743 E + F.

Levees.

Method of Constructing and Maintaining Peat Levees. Gives the conclusions and recommendations of Nathaniel Ellery for building up and maintaining peat levee systems. 2000 w. Engng-Con—Oct. 27, 1909. No. 9011.

Locks.

The Accident to the Poe Lock Gate at the St. Mary's Falls Canal, Sault Ste. Marie. Illustrated account of the accident on Nov. 10, when a steamer rammed the gate and put the lock out of commission for a week. 800 w. Eng News—Nov. 18. 1909. No. 9406.

Steel Forms for Lock Walls and Culverts at Gatun. Gives cross-section and plan of locks and illustrated description of forms used for both lock walls and culverts. 1000 w. Eng Rec—Oct. 30, 1909. No. 8970.

Mississippi River.

See U. S. Waterways, under WATERWAYS AND HARBORS.

Panama Canal.

Progress in the Construction of the Panama Canal. Photographs with summary of progress in excavation and construction work during the year ending June 30, 1909. 2500 w. Engineering Magazine—Dec., 1909. No. 9778 B.

The Work at Panama During the Last Fiscal Year. Information from the annual report of Lieut.-Col. George W. Goethals, for the year ending June 30, 1909. Ills. 9500 w. Eng Rec—Nov. 27, 1909. No. 9620.

The Panama Canal: A Work Worthy of National Pride. Editorial on the methods and cost of the work, and urging engineers in general to show their appreciation of the work. 2000 w. Eng News—Nov. 25, 1909. No. 9666.

See also Stone Crushing, under CONSTRUCTION; and Locks, under WATERWAYS AND HARBORS.

Piers.

Concrete Pier Construction on the Pacific Coast. H. H. Dunn. The new reinforced concrete wharf at Santa Monica, Cal., is illustrated and described. 1500 w. Cassier's Mag—Nov., 1909. No. 9309 B.

Pollution.

The Quality of Effluents in Relation to Standards. Gilbert John Fowler. Abstract of paper read before the Roy. San. Inst. Discusses the chemical meaning of various standard tests, and the effect of effluents on streams. Discussion. 7000 w. Surveyor—Nov. 19, 1909. No. 9684 A.

The Pollution of the Merrimack River. Extracts from the report to the Legislature by the Massachusetts State Board of Health, with editorial Comment. 6000 w. Eng News—Nov. 11, 1909. No. 9253.

U. S. Waterways.

Present and Prospective Commerce of the Mississippi River from St. Louis to the Gulf of Mexico. Condensed from Appendix No. 20 to the report of a Board of Engineers on the project for a 14-ft. deep waterway from the Lakes to the Gulf. Also editorial. Information of value on deep waterways. 10000 w. Eng News—Nov. 4, 1909. No. 9076.

Water Powers.

See Quebec, under MINING AND METALLURGY, IRON AND STEEL.

MISCELLANY.

Caisson-Work Hygiene.

Protective and Hygienic Provisions in Work in Compressed Air (Travaux à l'Air comprimé, Mesures de Protection et de Salubrité). The text of a circular issued by the French Minister of Labor, giving the provisions of the French law. 6800 w. Ann d Ponts et Chaussées—1909-V. No. 9744 E + F.

Regulation of Compressed Air Work in France. Notes from *Ann. des Ponts et Chaussées* indicating the scope of the regulations now in force. 1200 w. Eng Rec—Dec. 4, 1909. No. 9890.

We supply copies of these articles. See page 650.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radio-Telegraphy.

High Potential High Frequency Experiments. Frank P. Vaughan. Illustrated description of experiments with specially designed condenser for high frequency discharge. 4000 w. Can Elec News—Nov., 1909. No. 9027 C.

Experience with the Crystal Type of Wireless Detector. L. W. Thomas. A discussion of the relative merits of the perikon and carborundum crystal detectors. 900 w. Elec Wld—Nov. 18, 1909. No. 9394.

The Electrolytic Detector Studied with the Aid of an Oscillograph. G. W. Pierce. Abstract from *Phys Rev.* Describes investigations of mode of operating the electrolytic detector, a Braun's cathode-tube oscillograph being used to record the values of the current through the detector. 2000 w. Elect'n, Lond—Nov. 12, 1909. No. 9459 A.

The Bellini and Tosi Directional Wireless System; the New Experiments. A. de Courcy. Illustrated description of the work by these Italian scientists in the directing of wireless messages. 2500 w. Elec Rev, N Y—Oct. 30, 1909. No. 9019.

Submarine Cables.

See Electrometers, under MEASUREMENT.

Telephony.

Telephones. L. E. Wilson. Calls attention to the economy of a well-equipped installation, and describes the faults to which installations are liable. 2000 w. Elect'n, Lond—Nov. 19, 1909. No. 9679 A.

Telephone Trials with a Long-Distance Microphone. C. Egnér and I. G. Holmström. A short description of a number of experimental trials of a new microphone. 2500 w. Elect'n, Lond—Nov. 19, 1909. No. 9678 A.

Telephotography.

Berjonneau System of Telephotography. Brief description of a new French system. Ills. 1200 w. Sci Am Sup—Nov. 27, 1909. No. 9488.

DISTRIBUTION.

Current Rectifiers.

The Mercury Rectifier. Norman G. Meade. Illustrated description of the rectifier, explaining its uses. 1400 w. Power—Nov. 2, 1909. No. 9041.

Fuses.

Some Experiments on Single and Stranded Low-Tension Fuses. W. T. MacCall. Describes results of experiments to determine the variation of Preece's constant with change of diameter. 700 w. Elect'n, Lond—Nov. 19, 1909. No. 9677 A.

Wiring.

Architects' Wiring Specifications. S. Deutsch. Suggestions for electric-light wiring, telephones, and electric elevator service. 1500 w. Elec Rev, N Y—Oct. 30, 1909. No. 9018.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Parallel Operation of Machines with Series Fields. H. L. Beach. Discusses the precautions to be observed in making connections to these machines. 2000 w. Elec Jour—Nov., 1909. No. 9224.

A. C. Motors.

The Measurement and Calculation of Iron Losses in Rotary, Elliptical, and Alternating, Magnetic Fields (Beiträge zur Messung und Berechnung der Eisenverluste in elliptischen Drehfeldern und Wechselfeldern). Erich Rother. Reports an investigation on this subject and gives results. Ills. Serial. 1st part. 3500 w. Elektrotech u Maschinenbau—Oct. 17, 1909. No. 9723 D.

A. C. Turbo-Dynamos.

6000-Kilowatt Turbo-Alternator. Illustrates and describes a turbine of the Howden-Zoelly pattern, designed on the multi-stage impulse principle. 1000 w. Engr, Lond—Oct. 29, 1909. No. 9188 A.

Efficiency.

Modern Electrical Machinery: Its Design, Cost and Efficiency. L. Crouch. Gives curves dealing with the weight, speed, cost, efficiency and power factor of direct and alternating-current generators and motors. 2500 w. Elec Rev, Lond—Oct. 22, 1909. No. 9097 A.

Energy Movement.

Energy Movement in Dynamos (Der Energiestrom in Dynamomaschinen). Fritz Emde. Traces the movement of the energy from the axle of the dynamo to the transmission line. Ills. 2500 w. Elektrotech u Maschinenbau—Oct. 3, 1909. No. 9721 D.

Induction Motors.

No-Load Conditions in Self-Excited, Single-Phase, Shunt-Induction Motors. Val. A. Fynn. An investigation of how the no-load conditions and the design are affected by the torque conditions. Diagrams. 2500 w. Elec Wld—Nov. 18, 1909. Serial. 1st part. No. 9395.

Railway Motors.

See Controllers, under STREET AND ELECTRIC RAILWAYS.

Shafts.

See same title, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

We supply copies of these articles. See page 650.

Speed.

A Study of Steam-Turbine Driven Dynamos (Etude des Dynamos commandées par Turbines à Vapeur). F. Drouin. A discussion of the design of dynamos for high angular velocities. Ills. 4000 w. Génie Civil—Oct. 2, 1909. No. 9535 D.

Speed Control.

Varving the Speed of an Electric Motor. Cecil P. Poole. An explanation of the principal methods used to vary the speed of a shunt-wound motor running on a two-wire circuit. 2500 w. Power—Nov. 2, 1909. No. 9044.

ELECTRO-CHEMISTRY.

Amalgamation.

See some title, under MINING AND METALLURGY, GOLD AND SILVER.

Cells.

Cadmium Amalgam and the Weston Normal Cell. F. E. Smith. A report of investigations and conclusions in regard to the electro-motive difference which sometimes exists, etc. 1000 w. Elec Engr, Lond—Oct. 29, 1909. No. 9166 A.

Electric Furnaces.

Electrode Efficiency of Furnaces. Carl Hering. Describes more clearly than in a previous article the electrode efficiency and its bearing on the design of furnaces. 1800 w. Elec-Chem & Met Ind—Nov., 1909. No. 8999 C.

The "Pinch Effect" in Electric Furnaces of the Induction Type. Joh. Harden. Gives practical data obtained in a 60-kw. induction furnace of the Kjellin type. 2200 w. Elec-Chem & Met Ind—Nov., 1909. No. 9002 C.

Electro-Metallurgy.

Progress in the Electrometallurgy of the Light Metals (Fortschritte in der Elektrometallurgie der Leichtmetalle). Franz Peters. Reviews progress in the electrometallurgy of aluminium, magnesium, the alkaline earths, the alkali metals and antimony. Ills. 5300 w. Glückauf—Oct. 30, 1909. No. 9577 D.

Nitric Acid.

The Production of Nitric Acid by Electricity (Production électrique de l'Acide azotique). J. Audouin. A review of the various processes and apparatus for the fixation of atmospheric nitrogen. Ills. Serial. 1st part. 2000 w. Rev Indus—Oct. 23, 1909. No. 9531 D.

Nitrogen.

Hydro-Electric Nitrogen Works at Notodden, Norway. Brief outline of the Berkeland-Eyde process of fixing atmospheric nitrogen, with illustrated description of the works where the processes are carried out. 2500 w. Engng—Nov. 5, 1909. No. 9274 A.

Ozone.

The Present Status of Ozone. G. M. Dyott. Reasons for its slow development, and discussion of uses. 1500 w. Elec Wld—Nov. 4, 1909. No. 9070.

ELECTRO-PHYSICS.

Electromagnets.

Heating and Torque Tests of Electromagnets (Erwärmungs- und Zugkraftversuche an Elektromagneten). Alois Berninger and Robert Edler. Mathematical discussion and report of results. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—Oct. 31, 1909. No. 9727 D.

Induction.

New Methods of Representing Grahpically Electro-Magnetic Induction (Nouvelles Méthodes diagrammatiques pour la Représentation graphique de l'Induction électromagnétique). A. Mégroz. A continuation of an article on the relations between the factors which express the laws of electro-magnetic induction. Ills. Serial. 1st part. 2500 w. Bul Tech d l Suisse Rom—Oct. 10, 1909. No. 9525 D.

Radioactivity.

Preliminary Report on the Radioactivity of the Carnotite of Southwest Colorado. Herman Fleck and William G. Haldane. Ills. 1800 w. Qr of Colo Sch of Mines—Oct., 1909. No. 9324 N.

Spark Discharges.

Spark Discharges. H. S. Fierheller. A brief study of disruptive discharges. 1500 w. Ap Sci—Nov., 1909. No. 9601 C.

GENERATING STATIONS.

Accumulators.

The Use of Buffer Batteries in Connection with Electric Traction Systems. A. W. E. Harris. Abstract of paper before the Birmingham (Eng.) Assn. of Students of the Inst. of Civ. Engrs. Deals with general considerations governing the installation, describing the principal types of booster, and giving results obtained. 2000 w. Elect'n, Lond—Oct. 22, 1909. No. 9090 A.

The Gouin and Marseille Alkaline Iron-Nickel Accumulator (L'Accumulateur alcalin Fer-Nickel Système Gouin et Marseille). J. A. Montpellier. Illustrated description, with details of cost, and operation. 3000 w. L'Elecn—Oct. 2, 1909. No. 9517 D.

Boosters.

Economies Obtained with an "Entz" Booster on Fluctuating Loads. An illustrated account of what can be accomplished by a battery-booster plant. 2000 w. Ir & Coal Trds Rev—Nov. 5, 1909. No. 9281 A.

Central Stations.

An Oil-Engine Central Station. Illustrated description of a plant supplying Westerly, R. I., and the surrounding districts. 3500 w. Elec Wld—Nov. 11, 1909. No. 9203.

Power-House Economies in Baltimore. Horatio A. Foster. An account of problems encountered in the reconstruction and reorganization of the United Railways and Electric Company's plants in

Baltimore, after the great fire. Ills. 5500 w. Jour Fr Inst—Nov., 1909. No. 9329 D.

Plant of the Hartford Electric Light Company. Illustrated description of an interesting plant, in which was installed the first American Parsons turbine, the fourth Foster superheater, and the two largest boilers in the United States. 2500 w. Power—Nov. 30, 1909. No. 9695.

The Stepney Electricity Works. Illustrated detailed description of the Blyth's Wharf generating station and its equipment. 4000 w. Engr, Lond—Oct. 29, 1909. No. 9187 A.

Modern European Turbo-Electric Plants. Frank C. Perkins. Brief illustrated description of installations of interest at Munich, Cairo, Bielefield, and other places. 1500 w. Sib Jour of Engng—Nov., 1909. No. 9607 C.

See also Fuel Oil, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Economics.

Development of Electrical Undertakings. S. J. Watson. Chairman's address at Manchester meeting of Inst. of Elec. Engrs. A review of the points of interest during the last 15 years in connection with electric supply development. 8500 w. Elec Engr, Lond—Oct. 29, 1909. No. 9165 A.

The Advantages to Electric Companies of Central Station Steam Heating. Charles R. Bishop. Gives an outline of the history of district-heating, and the present state of the service in New England. 4400 w. Elec Age—Oct., 1909. No. 9119.

The Pros and Cons of Municipal Wiring. Deals with the hiring out of apparatus and the wiring of installations by municipal supply undertakings in competition with private enterprise. 7000 w. Elect'n, Lond—Oct. 29, 1909. No. 9168 A.

Hydro-Electric.

A Low-Head Power Development on the Tippecanoe River. Illustrated description of a plant in Indiana. 1500 w. Eng Rec—Nov. 27, 1909. No. 9627.

Hydroelectric Development of the Uncas Power Company at Scotland, Conn. Illustrated description of an interesting power development on the Shetucket River. 2500 w. Elec Wld—Oct. 28, 1909. No. 8994.

Tumwater Power Plant of the Great Northern Railway. Illustrated description of a plant supplying three-phase current for an electrical railway, and having unusual features of design to take care of a load having great fluctuations. 2000 w. Eng Rec—Oct. 30, 1909. No 8967.

See also Nitrogen, under ELECTRO-CHEMISTRY, and Lines, under TRANSMISSION.

Isolated Plants.

Electrical Equipment of the Luzerne County Court House. Illustrated description of a large installation at Wilkes-Barre, Pa., for lighting an important building, and furnishing 437 h. p. in motors. 1500 w. Elec Wld—Nov. 4, 1909. No. 9069.

Power Contracts.

Engineering Aspects of Large Power Contracts. Howard S. Knowlton. The first of two articles discussing the relations between the company and the consumer. 4000 w. Engineering Magazine—Dec., 1909. No. 9779 B.

LIGHTING.

Arc Lamps.

The Operation of Inclosed Arc Lamps. R. H. Fenkhausen. An illustrated description of their construction, operation, how to care for them, etc. 2000 w. Power—Nov. 16, 1909. No. 9321.

The Titanium Arc. William S. Weedon. Read before the Am. Elec.-Chem. Soc. Explains the characteristics of the titanium arc with direct current, and the preparation of the titanium carbide electrodes. Ills. 2000 w. Elec Rev, N Y—Nov. 27, 1909. No. 9635.

Illumination.

Standard Relations of Light Distribution. Arthur J. Sweet. Read before the Ill. Engng. Soc. An analysis of the problem of light distribution, aiming to establish standard relations that will simplify the problem of illumination. 4000 w. Elec Jour—Nov., 1909. No. 9222.

Incandescent Lamps.

The Useful Life of Metallic Filament Lamps (Vie utile des Lampes à Filament métallique). M. Henry. A discussion based on the results of official tests of Osram lamps in Germany, which are reproduced. 2000 w. L'Elecn—Oct. 2, 1909. No. 9518 D.

Photometry.

The Flicker Photometer. Sydney W. Ashe. On the use of this instrument in color photometry. 1000 w. Elec Wld—Nov. 25, 1909. No. 9654.

The Use of Selenium in Photometry. Joel Stebbins. A short account of the main features in the application of selenium to astronomical work. 2500 w. Technograph—1909. No. 9767 D.

MEASUREMENT.

Dynamo Testing.

Shop Testing: Direct and Alternating Machinery. J. W. Rogers. Read before the Rugby Engng. Soc. An account of the experimental tests made on all machines of new type. 6500 w. Elec Engr, Lond—Nov. 19, 1909. No. 9675 A.

Electrometer.

A Damped Quadrant Electrometer for Submarine Cable Testing. R. M. Sayers. Describes a modified Dolezalek quadrant

electrometer, and the method of using the instrument. Ills. 3000 w. Elect'n, Lond —Nov. 12, 1909. No. 9458 A.

Galvanometers.

Clark Fisher Galvanometers. Illustrated detailed description. 1100 w. Elect'n, Lond—Oct. 22, 1909. No. 9100 A.

Instruments.

Electrical Measuring Instruments. Classifies and describes these instruments, and gives rules and instructions for their testing by the Bureau of Standards at Washington. 17500 w. Bureau of Standards—Circ. No. 20. No. 9352 N.

Instrument Transformers.

Determination of the Constants of Instrument Transformers. P. G. Agnew and T. T. Fitch. Describes an application of the potentiometer method, the principle of which is the same for both series and shunt transformers. 1500 w. Elec Wld—Oct. 28, 1909. No. 8997.

Meters.

The Action of Direct-Current Meters on Rectified Circuits. Paul MacGahan. Considers the proper meters to use in measuring these currents. 1200 w. Elec Jour—Nov., 1909. No. 9225.

The Graphic Recording Meter and Its Relation to Individual Motor Drive in Industrial Operations. A. G. Popcke. Shows the value of automatically recording the operations of industrial plants by the use of these meters. Ills. 2000 w. Elec Jour—Nov., 1909. No. 9223.

Mercury Motor and Other Meters. E. P. Austin. Explains the principles of action and matters relating to types of service meters. Ills. 3000 w. Elec Rev, Lond—Nov. 19, 1909. No. 9676 A.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Units.

Electrical Units (Vue d'Ensemble sur les Unités électriques). C. de Baillehache. A general review of their history and a discussion of the movement to secure international uniformity. Serial. 1st part. 1500 w. Tech Mod—Oct., 1909. No. 9528 D.

The Relations of the Postulates of Mechanics with the "Dimension" Equations of Electrical Quantities (Note sur les Liaisons des Postulats de la Mécanique avec les Equations dites "de Dimensions" des Grandeurs électriques). P. Juppont. A mathematical discussion of electric units, with a reply by E. Brylinski and a rejoinder by M. Juppont. 13000 w. Bul Soc Int d Elecns—Aug.-Sept.-Oct., 1909. No. 9505 F.

POWER APPLICATIONS.

Cranes.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Development.

Fundamental Reasons for the Use of Electricity. Charles F. Scott. From a paper on "The Trend of Electrical Development," read at the Seattle convention. A general view of the constantly increasing applications of the electric current, the methods and effects. 5000 w. Elec Jour—Nov., 1909. No. 9221.

Electrical Power for Light and Tramways. W. M. Rogerson, Presidential address before the Leeds Local Soc. of the Inst. of Elec. Engrs. A retrospect of the supply of electricity for lighting, power, and tramways, comparing the present position with early dates. 4000 w. Elec Engr, Lond—Nov. 5, 1909. No. 9262 A.

Ship Propulsion.

See Electric Power, under MARINE AND NAVAL ENGINEERING.

TRANSMISSION.

Cables.

Practical Data for the Design of Underground Cables (Données pratiques sur le Calcul des Cables souterrains). J. Izart. Reproduces a valuable series of graphical charts. Ills. 1500 w. L'Elecn —Oct. 9, 1909. No. 9519 D.

See also Protective Devices, under TRANSMISSION, and Electric Power, under MINING AND METALLURGY, COAL AND COKE.

Cable Troubles.

Location of Faults in Underground Cables. William A. Durgin. Describes a new type of exploring coil, in which the winding is laid transverse to the cable, and the core parallel to the cable. Also editorial. Ills. 3000 w. Elec Wld—Nov. 25, 1909. No. 9653.

Lightning Protection.

Aluminium Electrolytic Lightning Arresters for Alternating-Current Lines (Parafoudres électrolytiques en Aluminium pour Réseaux à Courants alternatifs). Describes a recent invention of the French Thomson-Houston Company. Ills. 2500 w. L'Elecn—Oct. 16, 1909. No. 9520 D.

Line Design.

Discussion on "Output and Regulation in Long-Distance Lines," and "Calculations of the High-Tension Line." Frontenac, N. Y., June 29, 1909. 7500 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9342 F.

Lines.

The Transmission of Electrical Energy in Southern California. An outline of the generating apparatus and transmission systems of two systems supplying Southern California. 2500 w. Elec Wld—Oct. 28, 1909. No. 8995.

Notes on High Tension Transmission Lines in California. S. L. Foster. An appendix to the report of the Committee on Power Distribution, presented at meet-

ing of the Am. St. and Int. Ry. Engng. Assn. 3000 w. Eng News—Nov. 18, 1909. No. 9398.

A Swiss Power Plant. Stephen Q. Hayes. Illustrated detailed description of the high-tension transmission plant installed for transmitting power from Engelberg to Lucerne. 4000 w. Elec Age—Oct., 1909. No. 9118.

Protective Devices.

Protection of Electrical Equipment. P. M. Lincoln. Discusses the protection of electrical apparatus and transmission lines from the danger of breakdowns due to electrical surges. 3300 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9341 F.

A Differential System for the Protection of Cables and Transformers (Système differentiel de Protection pour les Cables et Transformateurs). Henri Michel. Illustrated description. 2600 w. Soc Belge d'Elecns—Oct., 1909. No. 9502 E.

Sub-Stations.

Difficulties in Sub-Station Practice. Gives typical instances of the difficulties encountered and the way in which they have been overcome. 1700 w. Elec Rev, Lond—Nov. 12, 1909. No. 9457 A.

Transformers.

Transformer Notes and Calculations. Gives solutions of some transformer problems. 1000 w. Elec Engr, Lond—Oct. 22, 1909. Serial. 1st part. No. 9096 A.

Test of a 3-kw. Westinghouse Type S Transformer. Antonio Guell and Hubert M. Turner. Describes the transformer, and methods used, giving results. Ills. 3500 w. Technograph—1909. No. 9771 D.

The Burning Out of Oil Transformers (Ueber die Entzündung von Oeltransformatoren). G. Molnar. Describes and discusses the probable cause of a peculiar case of inflammation some hours after operation had ceased. Ills. 2000 w. Elektrotech u Maschinenbau—Oct. 31, 1909. No. 9728 D.

Voltage Regulation.

Calculation of the Voltage Regulation of Transmission Lines. J. E. Dalemont. Gives two simple formulae, explaining their use for the calculation of the size of conductors and the voltage regulation of any transmission line with reaction and with any power factor. 900 w. Elec Wld—Oct. 28, 1909. No. 8996.

MISCELLANY.

Development.

Inaugural Address. Dr. Gisbert Kapp. Reviews the present position of electrical engineering, indicating the more important developments and general tendencies. Ills. 19000 w. Inst of Elec Engrs—Nov. 11, 1909. No. 9673 N.

Electrical Industry.

A Survey of the Electrical Industry. R. K. Morcom. Chairman's inaugural address to the Birmingham Local Section of the Inst. of Elec. Engrs. Analyzes details of production, exports, prices, distribution, etc. in England, the importance of training and of a knowledge of mathematics. 4000 w. Elec Engr, Lond—Nov. 12, 1909. No. 9456 A.

Magnet Steel.

Magnet Steel and Permanent Magnetism (Magnetstahl und permanenter Magnetismus). G. Mars. Discusses the characteristics, composition, and production of a satisfactory magnet steel. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—Oct. 27, 1909. No. 9563 D.

Marseilles Congress.

International Congress of the Applications of Electricity and Exposition at Marseilles (Le Congrès international des Applications de l'Electricité et l'Exposition de Marseille). F. Leprince-Ringuet. A report of the proceedings of the congress held Sept. 14 to 20, 1908. Ills. 18000 w. Ann d Ponts et Chaussées—1909—V. No. 9741 E + F.

INDUSTRIAL ECONOMY.

INDUSTRIAL ECONOMY.

Accounting.

Inventory Books for Lands, Buildings, Patterns, etc. (Inventarienbücher für Grundstücke und Gebäude, Modelle und sonstiges Inventar). C. M. Lewin. A discussion of inventory methods illustrated by a number of forms. 5000 w. Elektrotech u Maschinenbau—Oct. 3. 1909. No. 9722 D.

Agriculture.

National Wealth and the Farm. James J. Hill. Condensed from address before the Am. Bankers' Assn. Shows that the food supply of the United States will soon be needed for the population of the country, anl discusses the necessity of intelligent supervision of this industry. 1600 w. Eng News—Nov. 18, 1909. No. 9397.

Education.

Present Methods of Education. Julian Chase Smallwood. Discusses the importance of developing the reasoning faculties. 2000 w. Cassier's Mag—Nov., 1909. No. 9314 B.

The Place of Research in Education. Henry A. Miers. Discusses the educational and actual value of research, and the possibilities of original research for other than scientific students. 2000 w. Jour Soc of Arts—Nov. 5, 1909. No. 9234 A.

We supply copies of these articles. See page 650.

Electrical Inventions and the Training of the Electrical Engineer. J. A. Fleming. Lecture to the Faculty of Engng., Univ. College, London. Discusses present conditions, the education needed, opportunities, etc. 6500 w. Engng—Oct. 22, 1909. No. 9108 A.

Vocational Training for Manufacturing Communities. Edwin L. Shuey. Discusses the need of industrial training. 2000 w. Ind Engng—Nov. 15, 1909. No. 9492.

French Secondary Mining Schools. P. Dumaine. Information concerning the different grades, methods of organization and support, courses of study, etc. 3000 w. Mines & Min—Nov., 1909. No. 9057 C.

Sydney Technical College. J. F. Buchanan. Illustrated description of the foundry practice course of a modern Australian trade school. 2500 w. Foundry—Nov., 1909. No. 9047.

New Methods in Technical Education in the United States (Les nouvelles Méthodes américaines d'Enseignement technique et professionnel). H. Marchand. Reviews and comments upon recent suggestions and plans for the improvement of methods in the United States. 6000 w. Soc Belge d'Elecns—Oct., 1909. No. 9504 E.

Engineering.

The Relation of Engineering to Science and to Business. George Fillmore Swain. On the importance of research and the true scientific spirit in this profession, and of a knowledge of business methods. 7000 w. Jour Worcester Poly Inst—Nov., 1909. No. 9215 C.

Filing Systems.

Filing and Indexing System of Board of Water Supply of the City of New York. Alfred D. Flinn. A detailed description of a system devised for a large organization. 12000 w. Jour Assn of Engng Socs—Oct., 1909. No. 9698 C.

Industrial Accidents.

The Prevention of Accidents in Industrial Plants. Abstract of important points noted in a recent book issued by the Fidelity and Casualty Co. of N. Y. 6500 w. Ind Engng—Nov. 15, 1909. No. 9497.

Industrial Accidents and the Paris Museum of Safety Devices and Industrial Hygiene (Les Accidents du Travail et le Musée de Prévention des Accidents du Travail et d'Hygiéne industrielle de Paris). Charles Barrat. A review of the accident situation in France, and a description of the museum. Ills. Serial. 1st part. 4500 w. Tech Mod—Oct., 1909. No. 9529 D.

Industrial Museums.

See Industrial Accidents, under INDUSTRIAL ECONOMY.

Japan.

Japan. T. Good. An illustrated discussion of the coal, iron, and shipbuilding industries. 2200 w. Cassier's Mag—Nov., 1909. No. 9305 B.

Labor Insurance.

Organized Provision for Insurance against Illness in the Families of the Miners in Prussia (Die organisierte Fürsorge für die erkrankten Familienangehörigen der Bergleute in Preussen). Herr Schmid. Describes and discusses this extension of general labor insurance in Germany. Serial. 1st part. 2000 w. Glückauf—Oct. 16, 1909. No. 9575 D.

Management.

Organisation by Production Factors. A. Harmilton Church. This third article of a series discusses the elements of the land factor and its use. 4500 w. Engineering Magazine—Dec., 1909. No. 9784 B.

Economical Workshop Production. The present number considers the preliminary operations in manufacture; the drawing office, standardization, the toolroom, and distribution of work. 3300 w. Mech Wld—Oct. 29, 1909. Serial. 1st part. No. 9177 A.

Mexico.

Industrial Progress in Mexico. John Birkinbine. Information and data gathered during trips in 1905 and 1909. Ills. 5000 w. Pro Engrs' Club of Phila, No. 1073—July, 1909. No. 9335 D.

A Trail Through the Mountains of Oaxaca, Mexico. Henry E. Birkinbine. Describes the physical features, the people, their industries and habits. Ills. 4000 w. Pro Engrs' Club of Phila, No. 1074—July, 1909. No. 9336 D.

Municipal Ownership.

State and City Undertakings (Staat und Stadt als Betriebsunternehmer). Emil Schiff. A discussion of the working and results of municipal ownership of public utilities in Germany. Serial. 1st part. 5000 w. Tech u Wirt—Oct., 1909. No. 9733 D.

Natural Resources.

Conservation in Southern Appalachiana. Benjamin H. Case. Explains existing conditions and discusses the need of forest conservation, and its importance to the lumber, tanning, wood pulp and extract industries. Also refers to waterpowers, mineral and agrciultural developments. 2500 w. Mfrs' Rec—Nov. 18, 1909. No. 9377.

Public Utilities.

Going Value as an Element in the Appraisal of Public Utility Properties. William H. Bryan. On the meaning of "going value" and the method of determining it. 4500 w. Jour Assn of Engng Socs—Oct., 1909. No. 9699 C.

Standardization.

Standardization and its Influence on Engineering Industries. William Cawthorne Unwin. The substance of two

lectures dealing with the work of the Engineering Standards Committee, and explaining the economic advantages of standardization in these industries. 14000 w. Inst of Civ Engrs—1909. No. 9755 N.

Time Keeping.

See same title, under CIVIL ENGINEERING CONSTRUCTION.

Uruguay.

The Republic of Uruguay (République orientale de l'Uruguay). Félix Pernot. A brief review of its industrial development and resources. 2200 w. Rec de Métal—Oct., 1909. No. 9511 E + F.

Welfare Work.

The Sociological Side of the Mining Industry. W. H. Moulton. Reviews progress in Europe and the United States, reporting great improvement as compared with conditions 20 years ago. 5500 w. Eng & Min Jour—Oct. 30, 1909. No. 8986.

MARINE AND NAVAL ENGINEERING.

Battleships.

The Italian Battleship Roma. Dagnino Attilio. Illustrated description of this recently built first-class battleship. 1000 w. Int Marine Engng—Nov., 1909. No. 9035 C.

Destroyers.

High Speed Destroyers of the United States Navy. Illustration, with description of the "Flusser" and "Reid," and report of trials showing remarkable speeds. 800 w. Sci Am—Oct. 30, 1909. No. 8963.

Dredges.

A Rock-Lifting Dredger. Illustrated description of the hopper dredger Viscount Ridley, used in work at Blyth Harbor. 500 w. Engr, Lond—Nov. 12, 1909. No. 9479 A.

Electric Power.

Electrical Propulsion of Warships. H. J. Oram. Inaugural address to the Junior Inst. of Engineers. Brief discussion of systems proposed. 1800 w. Elec Engr, Lond—Nov. 19, 1909. No. 9674 A.

Applications of Electricity to Propulsion of Naval Vessels. W. L. R. Emmet. Gives data and information relating to two distinct methods, both adapted to the propulsion of battleships of the design of the Arkansas and Wyoming. Plates. 3500 w. Soc of Nav Archts & Marine Engrs, No. 5—Nov., 1909. No. 9296 N.

Ferry Boats.

The Ferry Service between Sassnitz, Germany, and Trelleborg, Sweden (Le Service de Ferry-Boats entre Sassnitz, Allemagne, and Trelleborg, Sweden). Brief description of the boats, slips, transfer tables, etc. Plate. Ills. 1600 w. Génie Civil—Oct. 23, 1909. No. 9542 D.

Gas Engines.

See Motor Boats, and Survey Vessels, under MARINE AND NAVAL ENGINEERING.

Motor Boats.

The Development of the Gasolene Power Boat. E. T. Keyser. Brief review, with illustrations. 1500 w. Soc of Nav Archts & Marine Engrs, No. 14—Nov., 1909. No. 9354 N.

The Producer Gas Boat Marenging. H. L. Aldrich. Illustrated description of this boat and the operation of the power-plant. 1700 w. Soc of Nav Archts & Marine Engrs, No. 6—Nov., 1909. No. 9230 N.

Oil Engines.

The Marine "Polar" Motor and its Utilization for Ship Propulsion (Der Marine-Polar-Motor und seine Anwendung als Schiffsmotor). Hugo Andersson. Describes a new design of Diesel motor and discusses its applicability to marine work. Ills. Serial. 1st part. 2000 w. Schiffbau—Oct. 27, 1909. No. 9581 D.

Propellers.

Evolution of Screw Propulsion in the United States. Charles H. Cramp. An interesting review of the development of screw propulsion. 6500 w. Soc of Nav Archts & Marine Engrs, No. 1—Nov., 1909. Serial. 1st part. No. 9226 N.

Graphical Treatment of the Propeller (Graphische Behandlung der Propeller). Ernst Sporleder. Illustrates the application of graphical methods to the solution of propeller problems. Ills. 1800 w. Die Turbine—Oct. 20, 1909. No. 9586 D.

Salvage.

Salvage of the United States Cruiser "Yankee" by Compressed Air. Explains the method by which compressed air is used for freeing a ship of water, and gives diagrams and description of the salvage of the "Yankee." Ills. 1200 w. Sci Am—Nov. 27, 1909. No. 9485.

Shipbuilding.

New Ship Yard at Ashtabula. Plan and description of this new yard of the Great Lakes Engineering Works. 2000 w. Marine Rev—Nov., 1909. No. 9295.

Ship Design.

Structural Rules for Ships. James Donald. Presents new rules for the construction of vessels, based on the best practice and arranged for ready reference. 18000 w. Soc Nav Archts & Marine Engrs, No. 11—Nov., 1909. No. 9317 N.

We supply copies of these articles. See page 630.

A System of Mathematical Lines for Ships. James N. Warrington. Describes the system, giving equations used. Drawings. 2500 w. Soc Nav Archts & Marine Engrs—Nov., 1909. No. 9355 N.

Strength of Water-Tight Bulkheads. William Horgaard. A theoretical study of the mathematcical formulæ useful in determining the strength of bulkhead stiffeners. 6000 w. Soc of Nav Archts & Marine Engrs, No. 13—Nov., 1909. No. 9298 N.

The Single-Deck Ship after the New Rules of the English Lloyd (Die Eindeckschiffe nach den neuen Regeln des Englischen Lloyd). Carl Kielhorn. An outline and review of the new rules. Ills. Serial. 1st part. 5000 w. Schiffbau—Oct. 13, 1909. No. 9580 D.

Ship Resistance.

The Effect of Parallel Middle Body Upon Resistance. D. W. Taylor. A report of tests made to determine whether there was, from the viewpoint of resistance, an optimum length of parallel middle body in a given case. Plates. 1600 w. Soc of Nav Archts & Marine Engrs, No. 2—Nov., 1909. No. 9227 N.

The Influence of the Position of the Midship Section Upon the Resistance of Some Forms of Vessels. H. C. Sadler. A report of experimental investigations. Plates. 500 w. Soc of Nav Archts & Marine Engrs, No. 3—Nov., 1909. No. 9228 N.

Steam Boiler.

Instructions for the Working and Management of Dürr Boilers. Considers the management of fires, cleaning of boilers, inspection, etc. 3500 w. Int Marine Engng—Nov., 1909. No. 9039 C.

How to Get the Best Efficiency from a Cochran Donkey Boiler. Suggestions for the handling of donkey boilers. 1000 w. Int Marine Engng—Nov., 1909. No. 9040 C.

How to Treat a Scotch Boiler in Order to Obtain the Best Results. B. A. M'Allister. Outlines methods of treatment, offering suggestions. 2800 w. Int Marine Engng—Nov., 1909. No. 9038 C.

The Operation and Care of Mosher Boilers. Suggestions for steaming, firing, cleaning boilers, repairs, etc. 2500 w. Int Marine Engng—Nov., 1909. No. 9032 C.

Proper Methods of Operating and Caring for a Yarrow Watertube Boiler in Order to Get the Greatest Efficiency. Information and instructions for laying up the boiler, firing, and treatment of feed water. 2000 w. Int Marine Engng—Nov., 1909. No. 9037 C.

Steam Engines.

Poppet Valves for Marine Engines (Ventilsteuenungen für Schiffsmaschinen). Joh. John. Describes and discusses various arrangements of valves. Ills. Serial. 1st part. 2500 w. Schiffbau—Oct. 13, 1909. No. 9579 D.

Steam Piping.

Machinery and Piping Arrangements on Board Ship. John M'Coll. The arrangement of the boiler-room is considered in the present article. 2500 w. Int Marine Engng—Nov., 1909. Serial. 1st part. No. 9036 C.

Steamships.

John Stevens' Part in the Development of Steam Navigation. A brief history of the work of John Stevens and his sons. Ills. 1600 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9344 F.

Channel Steamers. Arthur Barter. Illustrates and describes special features of steamships for service on the English Channel and Irish Sea. 2000 w. Cassier's Mag—Nov., 1909. No. 9311 B.

Fleet Colliers Mars, Vulcan and Hector. Illustrated description of these vessels and the propulsive machinery. 2800 w. Marine Rev—Nov., 1909. No. 9292.

Self-Discharging Cargo Steamers. Illustrates and describes vessels fitted with self-discharging gear. 1200 w. Marine Rev—Nov., 1909. No. 9293.

The Turbine Steamer "Umegaka Maru" for the Japanese Volunteer Fleet. Detailed description of a recently completed vessel. 1200 w. Engng—Nov. 5, 1909. No. 9277 A.

Steam Turbines.

The Design of Marine Steam-Turbines. Stanley John Reed. Notes on the reaction type of turbine developed by C. A. Parsons. Ills. Discussion. 21500 w. Inst of Civ Engrs, No. 3788—Feb. 16, 1909. No. 9757 N.

Speed Reduction and Reversing with Turbine Driving. Illustrated detailed description of the Föttinger transmitter for speed reduction and reversing of turbine drive on steamships, with report of results. 5000 w. Engng—Nov. 5, 1909. No. 9273 A.

See also Gears, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Stream Lines.

Some Ship-Shaped Stream Forms. William McEntee. Gives results of an investigation made to determine the variation of velocity of water when constrained to move in a plane along a form of the shape of a ship's water-plane. Plates. 2000 w. Soc of Nav Archts & Marine Engrs, No. 4—Nov., 1909. No. 9229 N.

Submarines.

The Design of Submarines. Marley F. Hay. A discussion of the present-day aspect of boats capable of complete submergence. 4000 w. Soc of Nav Archts & Marine Engrs, No. 8—Nov., 1909. No. 9231 N.

We supply copies of these articles. See page 650.

Survey Vessels.

Building and Equipping the Non-Magnetic Auxiliary Yacht Carnegie with Producer Gas Propelling Equipment. Wallace Downey. Illustrations, with brief notes on special features. 600 w. Soc of Nav Archts & Marine Engrs, No. 7—Nov., 1909. No. 9297 A.

Torpedo Testing.

The Schneider Torpedo-Testing Station. Illustrated description of the proving station in the Mediterranean, on the French coast. 3500 w. Sci Am Sup—Nov. 13, 1909. No. 9205.

U. S. Merchant Marine.

The Foreign Trade Merchant Marine of the United States:—Can It Be Revived? G. W. Dickie. A discussion of foreign trade shipping, with suggestions for meeting present requirements. 5500 w. Soc of Nav Archts & Marine Engrs, No. 9—Nov., 1909. No. 9232 N.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Adams.

A British Car with Desaxé Cylinders. Illustrated description of the 16 h. p. Adams which can be fitted either with "pedals-to-push," or the regular change-speed gear. 1000 w. Auto Jour—Nov. 6, 1909. No. 9257 A.

Argyll.

The Argyll 1910 Programme. Illustrates and describes new models. 1000 w. Autocar—Nov. 6, 1909. No. 9258 A.

Arrol-Johnston.

The New 15.9 h. p. Arrol-Johnston Car. Illustrated description of a new design of chassis built at Paisley, Scotland. 1200 w. Autocar—Oct. 30, 1909. No. 9159 A.

Brush.

The New Brush Models. Brief illustrated descriptions of models D26 and D28. 1200 w. Horseless Age—Nov. 17, 1909. No. 9424.

Carburettors.

Sound Carburettor Design. Illustrates and describes details of the Claudel-Hobson carburettor in the present article. 1200 w. Auto Jour—Nov. 20, 1909. Serial. 1st part. No. 9672 A.

Trend in Accessories of Necessity. Thomas J. Fay. Illustrated account of the development of the Schebler carbureter. 3000 w. Automobile—Nov. 25, 1909. No. 9633.

See also Motors, under AUTOMOBILES.

Commercial Vehicles.

Possibilities of the Commercial Automobile. W. W. Macfarren. Aims to show what has been accomplished in this field, and the present magnitude and almost unlimited growth the industry may attain. Ills. Also discussion. 14000 w. Pro Engrs' Soc of W Penn—Oct., 1909. No. 9331 D.

Construction.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Crossley.

A Running Description of a Notable Car. Illustrated description of the 12-14 h. p. four-cyclinder Crossley car. 1500 w. Autocar—Nov. 6, 1909. No. 9259 A.

Design.

The Road-Motors of the Present Day, and Some Unsolved Problems Connected with Them. Henry Capel Lofft Holden. James Forrest Lecture. Discusses problems yet to be solved in connection with mechanically-propelled vehicles, and the methods of generating power for their propulsion. 11000 w. Inst of Civ Engrs—April 26, 1909. No. 9754 N.

Electric.

Modern Electric Automobiles (Moderne Elektromobile). The first part describes the product of the Gottfried Hagen Accumulator Company, Köln Ills. Serial. 1st part. 3200 w. Zeitschr d Mit Motorwagen Ver—Oct. 31, 1909. No. 9592 D.

Exhibition.

Novelties in Car Design and Accessories Seen at the Atlanta Show. H. H. Brown. Brief illustrated descriptions of interesting exhibits. 2500 w. Horseless Age—Nov. 24, 1909. No. 9639.

The Motor-Car Show at Olympia. A general review of the tendencies shown in the exhibits, illustrating details of interest in various cars shown. 4500 w. Engng—Nov. 19, 1909. Serial. 1st part. No. 9687 A.

Gears.

Should Gears Progress Geometrically or Arthimetically. Louis Lacoin. Explains the meaning of these terms and their application to speed changes of automobiles. 2000 w. Automobile—Nov. 18, 1909. No. 9411.

Ignition.

Novelty in Magneto Design. Illustrated description of the Waco high-tension magneto, a reciprocating wireless armature. 1500 w. Auto Jour—Oct. 30, 1909. No. 9163 A.

Recent Tendencies in Ignition Equipment—Some New Systems. Albert L. Clough. Discusses details of various systems. 1800 w. Horseless Age—Nov. 10, 1909. No. 9304.

The Hall Dual Ignition System. Illustrated detailed description of a British

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made machine. 1000 w. Auto Jour—Nov. 13, 1909. No. 9454 A.

Advantages of Multiple Ignition Batteries. A. L. Haskell. Read before the Neb. Gas & Gasoline Engine Trds. Assn. An explanation of recent improvements in dry batteries and the results. 3000 w. Automobile—Nov. 18, 1909. No. 9412.

Inter-State.

Inter-State "40" Models for 1910. Illustrated description of improvements introduced in machines built at Muncie, Ind. 2200 w. Automobile—Nov. 11, 1909. No. 9237.

Lighting.

A Simple Dynamo for Car Lighting. Illustrates and describes the Electric Ignition Co.'s system of automatic accumulator charging. 2500 w. Auto Jour—Oct. 23, 1909. No. 9093 A.

"Carbic" for Automobile Headlights. Particulars in regard to a new fuel for acetylene lamps. Ills. 1000 w. Auto Jour—Nov. 6, 1909. No. 9256 A.

Motor Cooling.

Theory and Working of the Thermosyphon. D. Siebenmann. Trans. from the German. Illustrates and describes this system of circulation. 2000 w. Automobile—Nov. 25, 1909. No. 9632.

Air Cooling of Automobile and Aeronautical Motors (Zur Frage der Luftkühlung bei Automobil- und Flugmotoren). F. Ernstes. An examination of the possible efficiency of air-cooling systems. Ills. Serial. 1st part. 2500 w. Zeitschr d Mit Motorwagen Ver—Oct. 15 1909. No. 9591 D.

Motors.

Unit versus Multi-Unit Cylinder Construction. Albert L. Clough. Discusses the advantages and disadvantages of the types. 1800 w. Horseless Age—Nov. 17, 1909. No. 9425.

New English Ideas in Automobile Construction. Illustrated discussion of a number of new ideas in automobile construction. Engines and a few carbureters. 3800 w. Automobile—Nov. 11, 1909. No. 9236.

What the French Makers Are Now Producing. An illustrated review of recent models and modifications in motor cars and engines. 2000 w. Automobile—Nov. 18, 1909. No. 9410.

A Two-Stroke Super-Induction Motor. Brief illustrated description of engine invented by E. H. Micklewood. 1600 w. Autocar—Oct. 23, 1909. No. 9095 A.

The Hewitt Piston-Valve Engine. Illustrated description of a new engine shown at the Olympia show. 1500 w. Auto Jour—Nov. 20, 1909. No. 9671 A.

How the Power of an Old Engine was Increased. Oliver Light. Describes a change which increased the power 50 per cent. Ills. 3500 w. Automobile—Oct. 28, 1909. No. 9024.

Omnibuses.

The Motor Postal Service of the Bavarian Department of Posts and Telegraphs (Die Motorpostlinien der königl. bayerischen Posten und Telegraphen). Describes the cars, traffic, etc., on the numerous lines of this passenger and mail-delivery undertaking. Ills. Serial. 1st part. 1600 w. Motorwagen—Oct. 31, 1909. No. 9593 D.

Simplex.

Simplex Makes Two-Cycle Progress. An illustrated description of the Simplex three-post two-cycle motor and the chassis. 4000 w. Automobile—Nov. 18, 1909. No. 9413.

Sizaire.

A Fashion-Setting Voiturette. Illustrates and describes the latest 12 H. P Sizaire model. 2200 w. Auto Jour—Oct. 30, 1909. No. 9162 A.

Standard.

The Newest 20 h. p. Standard. Illustrates and describes the improvements introduced. 1500 w. Autocar—Oct. 23, 1909. No. 9094 A.

Sterling.

Sterling Model "O" to the Fore. Information concerning this series of cars. Ills. 1200 w. Automobile—Nov. 11, 1909. No. 9238.

Suspension.

The Cowey Pneumatic Suspension. Illustrates and describes a system which does away with the use of ordinary springs and gives easy riding even on solid tires. 2500 w. Auto Jour—Nov. 6, 1909. No. 9255 A.

Wolseley.

Wolseley Cars for 1910. General review, with detailed description of the 16-20 h. p. model. Ills. 600 w. Auto Jour—Nov. 13, 1909. Serial. 1st part. No. 9455 A.

The Wolseley-Siddeley Motor-Cars at Olympia. Illustrated description of the latest models. 2000 w. Engng—Nov. 12, 1909. No. 9469 A.

COMBUSTION MOTORS.

Aeronautic Motors.

Light Engines. An illustrated study of the engines at the Paris flight show. 2500 w. Auto Jour—Oct. 30, 1909. No. 9164 A.

Alcohol Engines.

See Fuels, under COMBUSTION MOTORS.

Carburetters.

Tangyes' Carburetter for Internal-Combustion Engines. Illustrated description of a design aiming to supply a mixture of air and liquid fuel in the same proportion whatever the speed, or load. 1000 w. Mech Engr—Oct. 22, 1909. No. 9105 A.

Crank Cases.

The Crank Case Problem. C. A. Dowley. Discusses the causes of difficulties in enclosed-crank case two-cycle motors.

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1500 w. Sib Jour of Engng—Nov., 1909. No. 9608 C.

Fuels.

Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines. Robert M. Strong. Summary of 2000 tests conducted by the U. S. Geol. Survey at St. Louis, Mo., and Norfolk, Va. 13000 w. U S Geol Survey—Bul. 392. No. 9322 N.

The Use of Alcohol in an Internal Combustion Engine. G. L. Guillet. Describes tests made in a Blackstone oil engine to find out the conditions necessary for the use of alcohol, and to compare this fuel with that for which the engine was built. Ills. 5500 w. Can Soc of Civ Engrs—Nov. 11, 1909. No. 9316 N.

Gas Engines.

The Rice Two-cycle Double-acting Gas Engine. Howard Greene. Illustrated description of this gas engine and its construction and operation. 3500 w. Am Mach—Vol. 32. No. 43. No. 9005.

Gas Engines (Moteurs à Gaz). A review of recent gas-engine literature and inventions. Ills. 6000 w. Rev de Mécan—Oct., 1909. No. 9515 E + F.

Gas Power Plants.

Gas Engine and Producer Installations for Manufacturing Plants. Percival Robert Moses. Gives comparative data of installation cost and operating economy. Ills. 3000 w. Engineering Magazine—Dec., 1909. No. 9785 B.

The New York Gas Producer and Gas Engine. Illustrated detailed description of a complete suction gas producer plant. 1800 w. Ir Age—Nov. 4, 1909. No. 9051.

Gas Producers.

The Effect of Varying the Degree of Saturation to a Suction-Gas Producer. Arnold Hartley Gibson and Reginald Duncan Gwyther. Reports a series of experiments to determine the effect on the thermal and general efficiencies of the producer, and on the entire plant. Ills. 5000 w. Inst of Civ Engrs—No. 3827. No. 9746 N.

Incidental Problems in Gas-Producer Tests. R. H. Fernald, C. D. Smith, J. K. Clement, and H. A. Grine. Discusses the proper length of a test period, and temperature differences in the fuel bed. Ills. 5500 w. U S Geol Surv—Bul. 393. No. 9214 N.

The Hill Bituminous Gas Producer. Illustrated description of a plant to gasify bituminous coal, lignite, peat, and low-grade fuels. 2000 w. Ir Age—Nov. 11, 1909. No. 9196.

See also Foundry Fuels, under MACHINE WORKS AND FOUNDRIES.

Gas Turbines.

The Explosion Gas Turbine. Henry Harrison Suplee. Gives data and results of recent tests. Ills. 1200 w. Cassier's Mag—Nov., 1909. No. 9313 B.

Ignition.

Electric Ignition of Internal Combustion Engines. John W. Warr. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Illustrated explanations of the various systems used. 5000 w. Elec Engr, Lond—Nov. 5, 1909. No. 9260 A.

Low-Tension Ignition-Gear for Gas-Engines. Illustrated description of a gear designed to eliminate every possibility of pre-ignition. 1000 w. Engng—Oct. 29, 1909. No. 9180 A.

Indicators.

A Continuous Explosion Engine Indicator. Dr. Charles W. Snyder. Illustrated description of a double drum indicator and its operation. 1000 w. Horseless Age—Nov. 24, 1909. No. 9638.

An Optical Indicator (Optischer Interferenzindikator). J. Kirner. Illustrated description of a new optical indicator for combustion motors. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 9, 1909. No. 9732 D.

Oil Engines.

See also Pumping Plants, under HYDRAULIC MACHINERY; Fuel Oil, under STEAM ENGINEERING; Oil Engines, under MARINE AND NAVAL ENGINEERING; and Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

HEATING AND COOLING.

Air Humidifying.

See Ventilation, under HEATING AND COOLING.

Air Liquefaction.

Liquid Air and its Application (La Liquéfaction de l'Air et ses Applications à la Fabrication de l'Oxygéne et de l'Azote). Georges Claude. An exhaustive discussion of its manufacture and use for the production of oxygen and ozone. Ills. 11000 w. Ann d Ponts et Chaussées—1909—V. No. 9740 E + F.

Central Plants.

See Economics, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Cooling Towers.

Cooling Towers for Steam and Gas Power Plants. J. R. Bibbins. With particular reference to the possibilities of the natural-draft auxiliary-draft type. Ills. 5500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9350 F.

Fans.

A Few Thoughts About Fans. Oswald Stott. From a paper read before the British Inst. of Heat. & Vent. Engrs. Gives data relating to both the propeller and centrifugal fans, discussing the effect of different sizes of fans and ducts. 1600 w. Heat & Vent Mag—Nov., 1909. No. 9605.

Fan Design (Zur Messtechnik des Ventilatorenbaues). M. Vidmar. A mathe-

matical discussion of some problems of calculation. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen —Oct. 30, 1909. No. 9590 D.

Hot-Air Heating.

A Notable School Furnace Heating Plant. Illustrated description of a furnace heating system proportioned on an engineering basis. 2500 w. Met Work —Nov. 6, 1909. No. 9114.

Hot-Water Heating.

Heating and Ventilation of the Museum of Fine Arts, Boston. Plans and description of the fan, coil, radiator, and duct installations of a plant which will ultimately serve a group of buildings. 3000 w. Eng Rec—Nov. 13, 1909. No. 9287.

Refrigeration.

Morris Cold Storage and Freezer Plant. Illustrated description of a large cold storage warehouse in Chicago. 1500 w. Ice & Refrig—Nov., 1909. No. 9132 C.

See also Evaporimeter, under MEASUREMENT; Fireproof, under CIVIL ENGINEERING, CONSTRUCTION.

School Buildings.

The Heating and Ventilating of School-Houses in Exposed Localities. Charles F. Eveleth. Considers fundamental points that must be kept in mind when planning the building. Describes briefly a number of systems. 5000 w. Am Archt —Nov. 17, 1909. (Special No.) No. 9447 F.

The Heating and Ventilation of Schools in Congested City Districts. Frank G. McCann. An illustrated discussion of the special problems in such buildings. 2000 w. Am Archt—Nov. 17, 1909. (Special No.) No. 9446 F.

Sanitation of the Modern School Building. Leo H. Pleins. A summary of important features of sanitary equipment of schools. 3000 w. Am Archt—Nov. 17, 1909. (Special No.) No. 9448 F.

Steam Heating.

Vacuum Steam Heating. R. W. Otto. Briefly describes the one-pipe, and the two-pipe systems of vacuum heating, discussing their economy, convenience, etc. 2500 w. Minn Engr—Nov., 1909. No. 9777 C.

Ventilation.

The Ventilation of Cotton Mills. An illustrated description of the conditions in the card-room, and the efforts being made to improve the ventilation. 2500 w. Engng—Nov. 19, 1909. No. 9686 A.

Ventilation and Structural Details of a Weave Shed. Brief illustrated description of gutter, skylight and ventilator details and of the apparatus for humidifying the air. 1500 w. Met Work—Nov. 20, 1909. No. 9408.

See also School Buildings, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Accumulators.

The Efficiency of Accumulator Pumps (Wirkungsgrad hydraulischer Akkumulierungs-Pumpanlagen). Herr Pfarr. Mathematical. Ills. 2500 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 20, 1909. No. 9587 D.

Centrifugal Pumps.

The Development of Centrifugal Pumps. J. D. Berg. From a paper presented at convention of the Central States Water-Works Assn. Discusses results of the development of centrifugal pumps, and recent installations. 2500 w. Eng News—Nov. 11, 1909. No. 9249.

Efficiency of the Centrifugal Pump. John B. Sperry. A detailed study of the three common methods used to find the efficiency. 2000 w. Power—Nov. 23, 1909. No. 9453.

Data for the Design of Centrifugal Pumps and Reaction Turbines (Berechnungs-Tabelle für Zentrifugal-Pumpen und Reaktions-Turbinen). Alfred Barbezat. Gives a number of data curves and tables, with explanation of their use. Ills. 4200 w. Schweiz Bau—Oct. 16, 1909. No. 9583 B.

The Operation of Centrifugal Pumps (Remarques sur le Fonctionnement des Pompes centrifuges). R. Tison. Theoretical and methematical. Ills. 2500 w. Rev de Mécan—Oct., 1909. No. 9514 E ⊥ F.

Hydrostatics.

The Time Required to Fill Floating Reservoirs (Ueber die Flutzeit schwimmender Behälter). M. Weitbrecht. Mathematical discussion. Ills. Serial. 1st part. 2500 w. Schiffbau—Oct. 13, 1909. No. 9578 D.

Pumping Engines.

"Cornish" Compound Duplex Quadruple-Acting Ram Pumping Engine. Illustrated description of engine installed at the Navigation Collieries, Crumlin. 700 w. Ir & Coal Trds Rev—Oct. 22, 1909. No. 9112 A.

Pumping Plants.

A 24,000,000-Gallon Pumping Plant. Charles C. De Wolf. Illustrated description of the Twenty-fourth avenue pumping station at Oakland, California. 1500 w. Cal Jour of Tech—Nov., 1909. No. 9327.

Huge Venturi Meters Registering 625 Cu. Ft. Per Second, Divi Island Pumping Plant, Madras, India. Illustrated description of plant for irrigation works in India, with record of pumping with Diesel engines. 1800 w. Eng News—Nov. 25, 1909. No. 9662.

See also Filtration, under CIVIL ENGINEERING, WATER SUPPLY.

Turbines.

See Centrifugal Pumps, under HYDRAULIC MACHINERY.

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MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Some Principles of Ball Bearing Design. J. F. Springer. An illustrated study. 1600 w. Sci Am—Nov. 6, 1909. No. 9077.

Bolts.

Determination of the Stresses in Bolts Subjected to Simple Tension (Détermination des Tensions dans les Piéces d'Assemblage soumises à Traction simple). H. Legros. Mathematical discussion of the stresses in bolted couplings. Ills. 3000 w. All Indus—Oct., 1909. No. 9523 D.

Flywheels.

A Suggestion for Flywheel Design. H. S. Brown. Illustrates and describes a type of built-up wheel. 1000 w. Power —Nov. 2, 1909. No. 9043.

Gears.

Experimental Spur-Wheel Reduction-Gear for High Speed Steam Turbines. Illustrated description of the Melville & Macalpine reduction gear and its action. 9500 w. Marine Rev—Nov., 1909. No. 9294.

See also Alloy Steels, under MATERIALS OF CONSTRUCTION.

Rivets.

Rivets in Tension. Robert Curr. Plate and brief discussion. 900 w. Soc of Nav Archts & Marine Engrs, No. 12—Nov., 1909. No. 9233 N.

Shafts.

Notes on the Design of Shafts, with Special Reference to High-Speed Electric Generators. H. H. Jeffcott. First of a series of articles giving results of an investigation of the lateral stability of rotation of loaded shafts and a discussion of the factor of safety which should be used in their design. 3000 w. Engr, Lond—Oct. 22, 1909. Serial. 1st part. No. 9109 A.

Slide Rules.

A Precision Slide-Rule. A. N. Lurie. Illustration and explanation of the advantages. 800 w. Technograph—1909. No. 9766 D.

Springs.

Notes on the Effect of Eccentricity of Loading in Spiral Springs. H. S. Rowell. Explains deviations, showing errors that may be introduced by eccentricity of loading. 600 w. Prac Engr—Nov. 12, 1909. No. 9464 A.

The Employment of Flexible Springs for Regulating the Operation of Motors (Sur l'Emploi de Ressorts à grande Flexion paur la Régularisation du Mouvement des Moteurs). L. Lecornu. Mathematical discussion of the possibility of regulating by means of springs the load on a motor driving a lighting dynamo and a pump. 1800 w. Rev de Mécan—Oct., 1909. No. 9512 E + F.

MACHINE WORKS AND FOUNDRIES.

Assembling.

Assembling a 24-Inch Engine Lathe. Alfred Spangenberg. Discusses the methods employed in machining, illustrating and describing the erecting process. 4000 w. Mach, N Y—Nov., 1909. No. 9091. C.

Case Hardening.

See Cementation, under MINING AND METALLURGY, IRON AND STEEL.

Castings.

Enclosed Cores in Castings. Walter J. May. Gives examples showing the method of dealing with curved cores, and some of the difficulties. Ills. 900 w. Prac Engr—Nov. 12, 1909. No. 9463 A.

Gray Iron Castings for Automobiles. Illustrates and describes methods pursued in their manufacture in a foundry making a specialty of this line of work. 4000 w. Foundry—Nov., 1909. No. 9046.

Chain Making.

Chain-Making Extraordinary in a Scrapless Press-Room. Chester L. Lucas. Illustrates and describes methods and machinery used in a Bridgeport, Conn., factory. 3000 w. Mach, N Y—Nov. 1, 1909. No. 9083 C.

Cordage Machinery.

The Machines that Make Cordage. Illustrates and describes the machines used in forming various fibers into rope. 2000 w. Sci Am Sup—Nov. 27, 1909. Serial. 1st part. No. 9489.

Cores.

See Castings, under MACHINE WORKS AND FOUNDRIES.

Cutlery Making.

The Cutlery Industry (L'Industrie de la Coutellerie). Henri Roberjot. A review of modern machines and practice in cutlery making. Ills. Serial. 1st part. 3000 w. Tech Mod—Oct., 1909. No. 9526 D.

Cutting Tools.

The Influence of Speed on the Cutting Action when Turning. H. S. Millar. An analysis of the cutting action when turning, particularly with the lower carbon steels, showing how speed affects the action. 1500 w. Am Mach—Vol. 32. No. 45. No. 9200.

Forging Hammers.

Board Drop-Hammer Design. H. Terhune. Discusses the general construction, adjustments, head construction, etc. Ills. 2200 w. Mach, N Y—Nov., 1909. No. 9089 C.

Foundry Fuels.

The Quality Demanded in Foundry Coke (Qualitätsanforderung für Giesereikoks). Oscar Simmersbach. A discussion of the importance of using a good quality of fuel. Ills. 4000 w. Stahl u Eisen—Oct. 6, 1909. No. 9558 D.

The Utilization of Lignite Briquettes in

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Iron and Steel Foundry Practice (Ueber die Verwendung von Braunkohlenbriketts in Eisen- und Stahlgiessereien). K. Krumbiegel. A review of various applications, including the generation of producer gas. Ills. 2800 w. Stahl u Eisen —Oct. 6, 1909. No. 9557 D.

Foundry Materials.

Carborundum and Carborundum Products Used in the Foundry. A. G. Rodgers. Read before the Phila. Found. Assn. Outlines the manufacture of carborundum, and considers its use as an abrasive, as a refractory material, and as a deoxidizing agent. 2000 w. Ir Age—Nov. 11, 1909. No. 0197.

Foundry Practice.

See Education, under INDUSTRIAL ECONOMY.

Furnaces.

Oil Burning Forges and Heaters. Illustrates and describes types of forge furnaces and other heaters. 1200 w. Am Mach—Vol. 32. No. 44. No. 9124.

Galvanizing.

Electro-Cementizing. Alfred Sang. Read at meeting of the Am. Elec.-Chem. Soc. Describes a process for simultaneously annealing, cleaning, and zinc-coating wire. 2500 w. Ir Age—Nov. 11, 1909. No. 9198.

Coating Iron and Steel With Copper, Brass and Bronze by the Hot Process. Describes a process developed by Walter S. Rockey and Hillary Eldredge, illustrating articles made. 1000 w. Brass Wld—Nov., 1909. No. 9483.

The Process of Sherardizing with Notes on Other Galvanizing Methods. J. H. Burn-Murdoch. Explains the disadvantages of the hot-dipping and electrogalvanizing processes, and gives an illustrated description of sherardizing, explaining its advantages. 2000 w. Brass Wld—Nov., 1909. No. 9482.

Gear Cutting.

Two Machine Tools—A Relic and the Original Thread Miller. W. J. Kaup. Illustrates and describes a gear cutter in use in 1851, and a thread miller built over 40 years ago. 1000 w. Am Mach—Vol. 32. No. 47. No. 9642.

Grinding.

Examples in Modern Grinding Practice. H. Darbyshire. Illustrates and describes accurate and economical work accomplished with grinding machines. 2500 w. Am Mach—Vol. 32. No. 43. No. 9007.

See also Shops, under MACHINE WORKS AND FOUNDRIES.

Grinding Machines.

The Bryant Chucking Grinder. Illustrated description of a new type applying the principles underlying the design of the turret lathe. 2500 w. Ir Age—Nov. 4, 1909. No. 9050.

Foot-Driven "Universal" Grinding-Machine at Olympia. Illustrated description of this tool equipped for power-driving, if required. 1000 w. Engng—Nov. 12, 1909. No. 9470 A.

Lathes.

Types of Turrets for Screw Machines and Turret Lathes. C. L. Goodrich. Illustrates and describes types of turret or tool-holding heads. 1200 w. Am Mach —Vol. 32. No. 43. No. 9008.

Norwegian Lathe of Modern Design. Illustrates and describes a lathe showing interesting and original design of the gearing in the head-stock. 700 w. Mach, N Y—Nov., 1909. No. 9092 C.

Machine Operations.

Analyzing Machine Operations with a Meter. A. G. Popcke. Illustrated description of the use of a graphic recording meter for the study of machine operations. 2500 w. Am Mach—Vol. 32. No. 46. No. 9391.

Machine Tools.

Machine Tool Design. Fred. Coxon. An illustrated article discussing modifications in British practice during the last twenty-five years. 3500 w. Cassier's Mag—Nov., 1909. No. 9306 B.

Pattern Making.

Elements of Pattern Construction. Joseph S. Horner. The first of a series of illustrated articles discussing problems of the model maker. 2000 w. Foundry —Nov., 1909. Serial. 1st part. No. 9049.

Pipe Fittings.

Pipe Fittings—Theory vs. Practice in Their Manufacture. F. W. Barrows. Considers the necessary attributes of a good fitting. 1200 w. Mach, N Y—Nov., 1909. No. 9088 C.

Pipe Threading.

Modern Machines for Pipe Threading. J. F. Springer. Illustrated descriptions of large pipe threading machines of recent design and examples of hand threading in inaccessible places. 3500 w. Am Mach—Vol. 32. No. 45. No. 9201.

Planing Machines.

Metal Planing Machines. George H. Benzon, Jr. Considers the principal elements of the reciprocating type of planing machines. 3000 w. Pro Engrs Club of Phila, No. 1071—July, 1909. No. 9333 D.

High-Speed Planing-Machine. Illustrated detailed description of machine constructed by Messrs. Loudon Bros., Ltd. 1000 w. Engng—Oct. 22, 1909. No. 9107 A.

Sand Blast.

A Revolving Sand-Blast Table (Rotationstisch mit eingebautem Sandstrahlgebläse). A description of a sand-blast cleaning device produced by the Alfred Gutmann A.-G., Ottensen. Ills. 1000 w.

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Elektrotech Rundschau—Oct. 2, 1909. No. 9718 D.

Screw Blanks.

Calculating the Size of Blank for Rolling Screw Threads. J. F. Springer. Explanation and meathematical solution of this problem. 1700 w. Mach, N Y—Nov., 1909. No. 9084 C.

Screw Machines.

See Lathes, under MACHINE WORKS AND FOUNDRIES.

Shapers.

Large Portable Shapers at Work. S. R. Stone. Illustrated description of portable draw shaper and its operation. 2200 w. Am Mach—Vol. 32. No. 44. No. 9123.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. Third and last of a series of articles, dealing with the installation of equipment, beginning of operations and fees. 7500 w. Engineering Magazine—Dec., 1909. No. 9786 B.

Shop Heating.

Notes on Shop Heating Plants. Warren H. Miller. On the design of such plants, and outlining a forced circulation hot water system. 3000 w. Am Mach—Vol. 32. No. 47. No. 9641.

Shop Hygiene.

The Hygiene of Glass Works (L'Hyglène dans les Verreries). Henri Mamy. Discusses the dangers of glass manufacture and means of combatting them. Ills. 2500 w. Génie Civil—Oct. 30, 1909. No. 0543 D.

Shop Management.

See same title, under INDUSTRIAL ECONOMY.

Shop Practice.

Precision in Parts Production. Thomas J. Fay. Considers the manufacture of parts in demand by companies who assemble cars. Ills. 1600 w. Automobile—Nov. 11, 1909. No. 9235.

Building a Ball-bearing Typewriter. Illustrates and describes some of the unusual operations such as turning ball races in a curved bar, automatic turning, etc. 2500 w. Am Mach—Vol. 32. No. 45. No. 9199.

The Making of Turbine Rotor Drums. Illustrates and describes the shop processes by which the rotor drums of steam turbines of large power are made. Plate. 2000 w. Engr, Lond—Nov. 12, 1909. No. 9478 A.

Some Interesting Checking Work. John Goetz. Methods used in a Milwaukee shop are illustrated and described. 800 w. Am Mach—Vol. 32. No. 44. No. 9125.

Shop Kinks. The collection of shop kinks by D. P. Kellogg, which won the first prize, and also a number of other collections. Ills. 3500 w. R R Age Gaz—Nov. 5, 1909. No. 9130.

See also Assembling, under MACHINE WORK AND FOUNDRIES; and Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shops.

A Machine Shop Without Cutting Tools. Illustrates and describes machines and fixtures used in building burglar-proof safes out of manganese steel, which can only be machined by grinding. 2000 w. Am Mach—Vol. 32. No. 47. No. 9640.

Manufacturing the Packard Automobile. Illustrated detailed description of the plant and methods of this Detroit factory. 6000 w. Ind Engng—Nov. 15, 1909. Serial. 1st part. No. 9491.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT; and under STREET AND ELECTRIC RAILWAYS.

Welding.

The Oxhydric Process of Cutting and Welding Metals. An illustrated account of its use in clearing the debris of the Pabst boiler explosion, describing the apparatus and adaptations. 2500 w. Ir Age—Nov. 11, 1909. No. 9193.

Plate Welding (Blechschweissung). C. Diegel. A discussion of the electric-resistance, electric-arc, autogenous and ordinary heating methods. Ills. 2500 w. Zeit d Oest Ing u Arch Ver—Oct. 1, 1909. No. 9704 D.

Wrenches.

Tap Wrenches. Illustrates and describes favorite types. 1200 w. Mech Wld—Nov. 19, 1909. No. 9682 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Aluminium-Copper-Tin Alloys. C. A. Edwards and J. H. Andrew. Read before the Inst. of Metals. A study of the constitution and properties of such alloys. Ills. 3000 w. Engng—Nov. 12, 1909. No. 9474 A.

Alloy Steels.

Observations on the Alloys of Iron and Manganese. Charles F. Burgess and James Aston. Discusses the use of manganese in steel employed for electric purposes, reporting peculiarities in the magmetic behavior of such alloys. 1500 w. Elec-Chem & Met Ind—Nov., 1909. No. 9001 C.

Titanium Alloy. Charles V. Slocum. An illustrated article reviewing trials of titanium alloy and the results. 1500 w. Sib Jour of Engng—Nov., 1909. No. 9609 C.

The Influence of Titanium on Steel, Particularly on Rail Steel (Der Einfluss des Titans auf Stahl, besonders auf Schienenstahl). Ed. von Maltitz. A review of tests on, and experiences with,

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titanium-steel rails. Ills. 5000 w. Stahl u Eisen—Oct. 13, 1909. No. 9559 D.

A Study of Steels for Gear Wheels. (Contribution à l'Etude des Aciers pour Engrenages). Louis Révillon. A review of the desirable qualities and a report of extended comparative tests of steels to determine the one most nearly possessing them. 15000 w. Rev de Métal—Oct., 1909. No. 9507 E + F.

Brass.

Brasses for Cartridge Cases and Projectiles and Electrolytic Copper (Laiton à Cartouches, Laitons à Balles.—Cuivre électrolytique). Captain Grard. An exhaustive study of the physical and metallographic properties of brasses, with special reference to their use in gun and projectile construction. Ills. 11500 w. Rev de Métal—Oct., 1909. No. 9510 E + F.

Brass Corrosion.

See Copper Corrosion, under MATERIALS OF CONSTRUCTION.

Cast Iron.

Notes on Malleable Cast Iron. Rodolfo Namias. Abstract translation of a paper read before the Int. Cong. of Ap. Chem. Considers things of importance in dealing with this material. 1500 w. Engng—Nov. 12, 1009. No. 9475 A.

Copper.

See Brass, under MATERIALS OF CONSTRUCTION.

Copper Corrosion.

Some Probable Causes of Corrosion of Copper and Brass. E. L. Rhead. Read before the Inst. of Metals. Gives some of the more common cases in which corrosion occurs, discussing causes. 3000 w. Mech Engr—Oct. 22, 1909. No. 9106 A.

Elastic Breakdown.

The Elastic Breakdown of Non-Ferrous Metals. C. Alfred M. Smith. Abstract of a paper read before the Inst. of Metals. A report of tests made on non-ferrous metals, including tension and compression tests, describing the author's sphingometer and its application. Ills. 3500 w. Mech Engr—Oct. 29, 1909. Serial. 1st part. No. 9176 A.

Malleable Iron.

See Cast Iron, under MATERIALS OF CONSTRUCTION.

Metallography.

The Iron-Carbon Law from the Viewpoint of Physical Chemistry (Le Leghe *ferro-carbonio* sotto il Punto di Vista chimico-fisico). Gino Gallo. A theoretical discussion. Ills. Serial. 1st part. 3200 w. Ann d Soc d Ing e d Arch Ital —Oct. 15, 1909. No. 9546 F.

Raw Materials.

Selective Economy in Raw Materials. Harry S. Mork. Discusses opportunities for the utilization of wastes. 3500 w. Sci Am Sup—Oct. 30, 1909. No. 8965.

Solders.

The Surface Appearance of Solders. C. O. Bannister and H. J. Tabor. Presented at meeting of the Inst. of Metals. An account of work of testing the varying conditions affecting the surface appearance. 2000 w. Foundry—Nov., 1909. No. 9048.

The Chemistry of Soldering Agents. A. Lippmann. A summary of experiments, chiefly with the "soft" type of soldering agents used in electrical work. 1000 w. Sci Am—Nov. 27, 1909. No. 9486.

Steel.

Treated Steel for High Service. Jas. H. Baker. An illustrated description of results obtained in the manufacture of high service steel. 5000 w. Ir Age—Nov. 25, 1909. No. 9637.

Slag Inclosures in Steel. Walter Rosenhain. Calls attention to the need of study of the influence on the strength and safety of steel by the presence of inclosures of non-metallic bodies. Ills. 2000 w. Ir Age—Nov. 18, 1909. No. 9378.

The Characteristics of the Curves of the Relation between the Hardness of a Steel and the Annealing Temperature after Tempering or after Cold Hardening (Allure des Courbes reliant la Dureté d'un Acier à la Température de Recuit après trempe ou après Ecrouissage). M. Grenet. Gives results of tests. Ills. 2000 w. Rev de Métal—Oct., 1909. No. 9508 E + F.

See also Magnet Steel, under ELECTRICAL ENGINEERING, MISCELLANY.

Tool Steels.

The Making of Tool Steel. Erik Oberg. Describes in detail the various processes and operations as carried out in works at Newark, N. J. Ills. 3000 w. Mach, N Y —Nov., 1909. No. 9087 C.

Wire Rope.

The Danger of Breaking in Wire Rope (Die Bruchgefahr der Drahtseile). Herr Bock. An exhaustive discussion of the strength of wire rope, and its safe use. Ills. Serial. 1st part. 4000 w. Glückauf —Oct. 23, 1909. No. 9576 D.

MEASUREMENT.

Evaporimeter.

A Cold-Storage Evaporimeter. Milo M. Hastings. Describes an instrument for measuring humidity. 3000 w. Ice & Refrig—Nov., 1909. No. 9133 C.

Hygrometry.

The Measurement of Humidity. Samuel K. Patteson. Considers practical engineering in its relation to atmospheric moisture. 2500 w. Cassier's Mag—Nov., 1909. No. 9307 B.

See also Evaporimeter, under MEASUREMENT.

Laboratories.

European Engineering Laboratories. Robert W. Angus. Brief descriptions of

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a number of laboratories recently visited. Ills. 5700 w. Ap Sci—Nov., 1909. Serial. 1st part. No. 9600 C.

Melting Point.

I. Melting Point Determination. Walter P. White. Treats of melting phenomena in general. II. Melting Point Methods at High Temperatures. Walter P. White. Describes the furnace technic used. 12500 w. Am Jour of Sci—Nov., 1909. No. 9217 D.

Sphingometers.

See Elastic Breakdown, under MATERIALS OF CONSTRUCTION.

Steam Meters.

The Pitot Tube as a Steam Meter. George F. Gebhardt. Describes a number of applications of the Pitot tube for steam measurements as constructed and tested at the Armour Institute of Technology. 2000 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9351 F.

Torsion Meters.

Some Investigations with a New Form of Torsion Meter. Illustrated detailed description of the Denny-Edgecombe torsion meter and recording apparatus, with diagrams and indicator cards taken. 2500 w. Engr, Lond—Nov. 5, 1909. No. 9278 A.

Units.

On the Origin of the British Measures of Capacity, Weight and Length. Wilfrid Airy. Discusses the origin of the British pint, pound avoirdupois, and foot. 4000 w. Inst of Civ Engrs—No. 3836. No. 9753 N.

Vacuum Gauges.

See same title, under STEAM ENGINEERING.

Venturi Meters.

See Pumping Plants, under HYDRAULIC MACHINERY.

Water.

The Measurement of Water in Industrial Establishments. J. A. Knesche. Illustrates and describes the Pitot tube and its use, giving information and test results. 5500 w. Ind Engng—Nov. 15, 1909. No. 9493.

Experiments with Double Pitot Tubes. Concerning Experiments made in Berlin by K. Ellon and Prof. E. Reichel to determine the value of double Pitot tubes in measuring the flow of water. Ills. 1000 w. Eng Rec—Nov. 27, 1909. No. 9626.

POWER AND TRANSMISSION.

Air Compression.

See Tidal Power, under POWER AND TRANSMISSION.

Air Compressors.

Compressor Designing—The Distribution of the Load. Frank Richards. Illustrated description of the three-stage air-compressor, designed to compress to 1000 pounds per square inch. 1000 w. Mach, N Y—Nov., 1909. No. 9085 C.

Cross-Compound Two-Stage Air Compressor. Illustrates and describes a vertical tandem compound type, with Kösters valve gear, capable of dealing with about 1000 cubic feet of air per minute, compressing it to 100 lb. per sq. in. Plate. 500 w. Engr, Lond—Oct. 29, 1909. No. 9186 A.

Air-Compressor Installations in Mexican Mines. P. A. Babb. Abstracted from paper before the Mex. Inst. of Min. & Met. Makes a comparison as to first cost between the systems used in Mexico and the United States,—the central plant and the individual unit. 2500 w. Min Wld—Nov. 20, 1909. No. 9439.

Recent Air-Compressor Performances (Neuere Ausführungen von Kompressoren). E. W. Köster. Reviews a number of recent machines and their results. Ills. Serial. 1st part. 1500 w. Zeitschr d Ver Deutscher Ing—Oct. 9, 1909. No. 9731 D.

The Piston Compressor and the Turbo-Compressor (Der Kolbenkompressor und der Turbokompressor). J. Havlicek. Reports a comparative test to determine the steam consumption. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 30, 1909. No. 9738 D.

Belt Driving.

Some Causes of Belt Failures. G. S. Baker. Shows how a large percentage of unnecessary costs of belting could be eliminated. Ills. 2200 w. Mach, N Y—Nov., 1909. No. 9090 C.

Compressed Air.

The Transmission of Power by Compressed Air. Arthur J. Colville. Points relating to pneumatic installations are discussed. 1400 w. Mech Wld—Nov. 5, 1909. No. 9268 A.

Electric Driving.

Some Temporary Motor Connections. C. V. Hull. Diagrams and description of novel arrangements to fulfill temporary needs. 1000 w. Power—Nov. 30, 1909. No. 9697.

The Economy of the Electric Drive in the Machine Shop. A. L. De Leeuw. Shows the points which affect the economy of the electric drive, and the proper relation between the motor and the driven machine. 9000 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9346 F.

See also Meters, under ELECTRICAL ENGINEERING, MEASUREMENT; and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Lubricants.

The Technical Selection of Railroad Oils as Applied to Cost Reduction. A. D. Smith. Considers what constitutes a "technical selection" of an oil, suitable specifications, etc., with discussion. 8000 w. Pro Ry Club of Pittsburg—Sept. 24, 1909. No. 9326 C.

Efficiency Tests of Lubricating Oils.

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Frederick H. Sibley. Describes tests made at the Case School of Applied Science, with the object of determining the relation between viscosity and the wearing and lubricating qualities of oils, and the effect of the constituents on the lubricating qualities. 1800 w. Jour Am Soc of Mech Engrs—Nov., 1909. No. 9345 F.

Lubrication.

Some Tests of Grease Lubrication. Tests made with the object of determining the ability to endure extreme bearing pressures. 1500 w. Power—Nov. 9, 1909. No. 9193.

Mechanical Plants.

Mechanical Equipment of the Washington Municipal Building. Describes the mechanical plant for a 5-story structure, occupying an entire square. Ills. 4000 w. Eng Rec—Oct. 30, 1909. No. 8974.

Power Plants.

Public Service Corporation Power Plant. Warren O. Rogers. Illustrated description of the steam turbine plant in Jersey City. 1800 w. Power—Nov. 23, 1909. No. 9452.

Power Costs for Factories. F. W. Ballard. Presidential address by F. W. Ballard, before the Ohio Soc. of Mech., Elec. and Steam Engrs. Suggestions for securing economy. 4500 w. Eng Rec—Nov. 27, 1909. No. 9624.

The Smallest Machine Shop Power Plant. Illustrated description of a small power plant in Glenora, Ont. 800 w. Am Mach—Vol. 32. No. 43. No. 9006.

Shafting.

Stresses Due to Bending and Twisting and the Design of Shafting. A. Lewis Jenkins. Gives results based on theory and observations, and the conclusions. Mathematical. 3000 w. Engng—Nov. 12, 1909. No. 9468 A.

Tidal Power.

Tidal Air Compression. W. O. Webber. Describes the manner of utilizing the tides on the coast for air compression, comparing costs and discussing the adaptability of air power. Ills. 2200 w. Compressed Air—Nov., 1909. No. 9498.

STEAM ENGINEERING.

Boiler Design.

Layout of an Irregular Pipe Intersecting a Large Cylinder at Right Angles. C. B. Linstrom. Shows how the principles of projection and triangulation drawing are applied to irregular pipe intersections. 1200 w. Boiler Maker—Nov., 1909. No. 9120.

Some Defects in Boiler Design (Di alcuni Vizi di Forma delle Caldaie). Guido Perelli. A criticism of some features of modern boiler design. Serial. 1st part. 1800 w. Industria—Oct. 17, 1909. No. 9552 D.

Boiler Draft.

Chimney Losses and Forced Draft (Schornsteinverluste und künstlicher Zug). G. Künzel. A discussion of draft in relation to boiler economy. Ills. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 23, 1909. No. 9569 D.

Boiler Efficiency.

Boiler Efficiencies for Various Coals. T. F. J. Maguire. This second article of a series considers guarantees of economy and methods of ascertaining efficiency of fuels. 2200 w. Engineering Magazine—Dec., 1909. No. 9782 B.

Boiler Explosions.

Destructive Boiler Explosion at Milwaukee. Osborn Monnett. An illustrated account of the explosion of four water-tube boilers at Pabst's brewery plant. 1000 w. Power—Nov. 9, 1909. No. 9191.

Boiler Explosion at Amoskeag Mills. Brief illustrated account of the explosion on Oct. 12, of a Manning boiler. 500 w. Power—Nov. 9, 1909. No. 9192.

Boiler Failures.

Another Butt-Strapped Joint Failure. Illustrated description of a boiler rupture at Torrington, Conn. 800 w. Power—Nov. 30, 1909. No. 9696.

Boiler Management.

Boiler Room Economy. William Kavanagh. Suggestions for securing economy in operation. 600 w. Elec Wld—Nov. 4, 1909. No. 9071.

Boiler House Losses. O. L. Peard. Describes the fuel losses, discussing methods of detection and reduction. 5000 w. Elect'n, Lond—Nov. 5, 1909. No. 9264 A.

The Care of Small Steam Boilers. Warren O. Rogers. Discusses some of the dangers caused by neglect. Ills. 1800 w. Power—Nov. 16, 1909. No. 9319.

See also Steam Boilers, under MARINE AD NAVAL ENGINEERING.

Boiler Plants.

Power Plant Economies as Applying to Mining. Hartwell Jalowick. On the saving that may be effected in the boiler house. 1200 w. Eng & Min Jour—Nov. 27, 1909. No. 9651.

Boiler Scale.

Experiences with Boiler Scale. William Henderson. Read before the Inst. of Marine Engrs. An account of experiences on a tramp steamer. 2500 w. Mech Engr—Nov. 12, 1909. No. 9466 A.

Boiler Testing.

Testing House Heating Boilers. Views of the University of Illinois engineering experiment station regarding suitable methods of investigating boiler performance. Ills. 3500 w. Met Work—Nov. 27, 1909. No. 9634.

Boiler Tests.

The Agreement of Theory and Practice in Steam Boiler Tests. Frank Kingsley. Discusses the heating surface and gives curves and a study of results of tests. 1500 w. Eng Rec—Nov. 6, 1909. No. 9149.

A Service Test of Internally-Fired

We supply copies of these articles. See page 650.

Boilers. A report of tests made at Green River, Wyo., on internally-fired, horizontal return tubular boilers to determine means of improving their efficiency. 1000 w. Eng Rec—Oct. 30, 1909. No. 8969.

Condensers.

Modern Condenser Design; a Good Example and a Remarkable Test Result. Illustrates and describes the Wheeler condensers at the Kent Ave. Station, Brooklyn. 1800 w. Elec Rev, N Y—Nov. 27, 1909. No. 9636.

Condensers for Steam Turbines (Ueber Dampfturbinen-Kondensation). Wilhelm Gentsch. A detailed discussion of turbine-condenser problems, condenser arrangements, etc. Ills. Serial. 1st part. 2000 w. Die Turbine—Oct. 5, 1909. No. 9585 D.

Cooling Towers.

See same title, under HEATING AND COOLING.

Economizers

Fuel Economizer Practice. William Kent. Gives table showing theoretical economic results possibly attainable under specified conditions, and related information. 1500 w. Ind Engng—Nov. 15, 1909. No. 9404.

Engine Economy.

A Method of Determining the Steam Consumption of a Compound Engine when Steam is Drawn from the Intermediate Receiver for Heating and Other Purposes (Un Modo di Determinare il Consumo di Vapore nelle Motrici compound con Utilizzazione del Vapore intermedio). G. Ghersina. 2000 w. Industria—Oct. 3, 1909. No. 9551 D.

Engine Governing.

Governing Rolling Mill Engines. W. P. Caine. A detailed study of the operation of rolling-mill engines, showing the difference in performance obtained by adding one adjusting screw to the governor. 2200 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9349 F.

Engines.

Uniform Torque in Steam Engine Practice. A discussion principally of high speed engines of medium size, considering the single-compound and tandem-compound types. 2000 w. Heat & Vent Mag—Nov., 1909. No. 9606.

Engine Valves.

Engines with Piston Valves (Etude sur les Machines à Tiroirs pistons). E. Lefer. Results of an investigation of steam distribution and leakage with piston valves. Ills 2100 w. Rev de Mécan—Oct., 1909. No. 9513 E + F.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Feed-Water Heating.

Feed Heating. W. W. Adamson. Prize Essay, Inst. of Marine Engrs. A summary of advantages accruing from raising the temperature of the feed water. 2500 w. Mech Engr—Nov. 5, 1909. No. 9266 A.

Flue-Gas Analysis.

A Description of the Methods of Gas-Sampling and Testing Employed by the Hamburg Smoke Abatement Society. John B. C. Kershaw. 600 w. Elec Rev, Lond—Oct. 22, 1909. No. 9098 A.

The Automatic Analysis and Registration of the Gases of Combustion (L'Analyse automatique et enregistrée des Gaz de la Combustion). Léonce Fabre. Brief descriptions of a number of Continental types of apparatus. Ills. 1600 w. Rev d'Econ Indus—Oct. 16, 1909. No. 9500 D.

Fuel Oil.

Sixth Annual Convention of the Association of Austrian and Hungarian Central Stations (Die VI. Jahresversammlung der Vereinigung österreichischer und ungarischer Elektrizitätswerke). Report of a discussion on the possibility of using oil as fuel under boilers and in motors. 4000 w. Elektrotech u Maschinenbau—Oct. 24, 1909. No. 9726 D.

Fuels.

Combustion. W. Inchley. A concise explanation of the theory of the combustion of various fuels. 900 w. Prac Engr—Oct. 29, 1909. Serial. 1st part. No. 9172 A.

Fuel Tests.

Fuel Tests with Illinois Coal. L. P. Breckenridge and Paul Diserens. Gives the important results of the government tests so far as they relate to Illinois coals. Ills. 9000 w. Univ of Ill Bul, Vol. VI., No. 18—Dec. 22, 1908. No. 9210 N.

Heat Transmission.

Heat Transmission in Pipe Lines (Der Wärmeübergang in Rohrleitungen). Wilhelm Nusselt. Mathematical discussion of the theory of heat transmission through pipe walls. Ills. Serial. 1st part. 4800 w. Zeitschr d Ver Deutscher Ing—Oct. 23, 1909. No. 9736 D.

Stacks.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Steam Meters.

See same title, under MEASUREMENT.

Steam Piping.

The Loss of Heat from Uncovered Steam Pipes. William Ledyard Cathcart. An illustrated study of the radiation of heat from bare piping. 5000 w. Cassier's Mag—Nov., 1909. No. 9312 B.

The Design of Steam Pipe Lines. T. K. Roberts. Gives directions for calculating the diameter of steam pipe, with example illustrating the use in design of tables given. 2500 w. Ind Engng—Nov. 15, 1909. No. 9496.

Some Points About Drips. George W. Martin. Illustrated discussion of the best manner of arranging the piping of steam-power plants to take care of drips. 900 w. Power—Nov. 2, 1909. No. 9042.

See also same title, under MARINE AND NAVAL ENGINEERING.

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Turbine Design.

Modern Tendencies in Steam Turbine Design. A. P. Chalkley. Considers the weak points in the Parsons and the Curtis types, suggesting a combination that would seem to contain the elements of success. 1500 w. Elec Rev, Lond—Oct. 29, 1909. No. 9167 A.

Turbine Economy.

Steam Turbine Performance. J. C. Thorpe. Shows the success attained in recent steam turbine practice by considering special installations and giving results of steam economy tests. Ills. 3000 w. Technograph—1909. No. 9770 D.

Turbine Limitations.

Some Limitations of the Steam Turbine. Warren H. Miller. Points out limitations to the service expected of steam turbines. 2500 w. Power—Nov. 2, 1909. No. 9045.

Turbine Nozzles.

Efficiency Tests of Steam Turbine Nozzles. Prof. Frederick H. Sibley and T. S. Kemble. An illustrated report of tests made and results. 4500 w. Jour Am Soc of Mech Engrs—Mid-Nov., 1909. No. 9348 F.

Turbine Plants.

Tests of a Small Steam-Turbine Plant. George W. Martin. Gives data of tests of the boiler and steam-turbine equipment of the plant at Pine Bluff, Ark. 3500 w. Elec Wld—Nov. 18, 1909. No. 9393.

Turbines.

The Exhaust Steam Turbine. Abstract of a paper by J. N. Bailey, read before the Manchester Assn. of Engrs. Showing the value of an exhaust steam plant. 1300 w. Engr, Lond—Nov. 19, 1909. No. 9691 A.

Exhaust Steam Turbines in Collieries and Rolling Mills. A. P. Chalkley. Considers the economies to be effected by such installations, particularly where reciprocating engines are working under unfavorable conditions. Ills. 1500 w. Elect'n, Lond—Oct. 29, 1909. No. 9170 A.

A Steam Turbine with Clearance Expansion (Dampfturbine mit Spaltexpansion). J. Rademacher. Describes a new design for steam and gas turbines. Ills. Serial. 1st part. 4000 w. Zeitschr f d Gesamte Turbinenwesen—Oct. 20, 1909. No. 9589 D.

A Note on General Turbine Theory (Beiträge zur allgemeinen Turbinentheorie). Viktor Fischer. Mathematical discussion of the variability of the flow of the impelling medium. Ills. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Oct. 20, 1909. No. 9588 D.

The Oerlikon Steam Turbine (La Turbine à Vapeur Oerlikon). Ch. Dantin. A brief general description. Ills. 3200 w. Génie Civil—Oct., 1909. No. 9536 D.

The Schulz Steam Turbine. Illustrated description of its general construction and the special advantages claimed for this turbine, well-known in Europe. 1500 w. Engr, Lond—Nov. 5, 1909. No. 9280 A.

See also Condensers, under STEAM ENGINEERING; and A. C. Turbo-Dynamos, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Vacuum Gauges.

Brotherhood's Vacuum Gauge-Tester. Illustrated description of this instrument. 700 w. Engng—Oct. 29, 1909. No. 9181 A.

Valve Setting.

Setting of the Valves of the Twiss Engine. Information for setting the valves of the Twiss automatic-cutoff engine, and describing its special features. Ills. 1000 w. Power—Nov. 16, 1909. No. 9320.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Handling Material by the Telpherage System. Dr. Alfred Gradenwitz. Illustrates and describes examples of German installations for foundry storage yards and blast furnaces. 1200 w. Ir Trd Rev—Nov. 11, 1909. No. 9239.

Transportation by Electrical Suspended Railway. A. Gradenwitz. An illustrated account of an installation at Copenhagen in which five systems of suspended railway economically handle all transportation. 1500 w. Eng & Min Jour—Nov. 6, 1909. No. 9136.

Cableways.

Attributes of Curves Described by Moving Loads on Suspended Cables. William Hewitt. Mathematical analysis of the design of aerial tramways. 3000 w. Ind Engng—Nov. 15, 1909. No. 9495.

The Panama Canal Cableways. Illustrated description of the cableways for handling broken stone, sand, etc., and their method of operation. 1600 w. Ir Age—Nov. 11, 1909. No. 9195.

See also Ore Handling, under TRANSPORTING AND CONVEYING.

Car Dumping.

See Coaling Plants, under CIVIL ENGINEERING, CONSTRUCTION.

Coal Handling.

Modern Methods of Coal Transport in Washing Plants (Moderne Transportvorrichtung in der Kohlenaufbereitung). Hans Keckstein. A mathematical discussion of the various transport devices. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 2, 1909. No. 9565 D.

Tests of a Coal-Loading Plant in Kosel (Versuche an der Kohlenumladeanlage in Kosel). W. Kammerer. Describes and reports tests on an important German plant for loading canal boats. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1909. No. 9730 D.

Conveyors.

See Tailings Conveyors, under MINING AND METALLURGY, ORE DRESSING AND CONCENTRATION.

Cranes.

160-Ton Electric Revolving Cantilever Crane. Illustrated detailed description. 1600 w. Engr, Lond—Nov. 19, 1909. No. 9693 A.

Electric Cranes. Warren H. Miller. Information concerning 20-ton hand-operated traveling cranes, with illustrated descriptions of various types of electric cranes and their advantages. 2000 w. Elec Wld—Nov. 11, 1909. No. 9204.

Elevators.

Starting, Running, and Stopping Times of Hydraulic Lifts Operated by Accumulators (Einschalt-, Anlauf- und Ausschaltperiode der Druckwasserhebemaschinen beim Betriebe durch Gewichtakkumulatoren). Karl Mayer. Mathematical. Ills. 4000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 29, 1909. No. 9709 D.

Freight Handling.

Terminal Freight Handling by Electrical Machinery. H. McL. Harding. A comparison of conditions in the United States and Europe, showing the United States to be far behind in this field. Ills. Discussion. 12000 w. Pro St Louis Ry Club—Oct. 8, 1909. No. 9211.

Material Handling Equipments for Lake Vessels. Richard B. Sheridan. Outlines the history of shipping on the Great Lakes, showing the great improvement in the handling of cargoes, and the effect on the industry. Ills. 12000 w. Soc of Nav Archts & Marine Engrs, No. 10—Nov., 1909. No. 9353 N.

Grain Handling.

Some Recent Grain-handling and Storing Appliances at the Millwall Docks. Magnus Mowat. Illustrates and describes an installation consisting of elevators, silos, granary and labor-saving appliances for handling, weighing, etc. Discussion. 12500 w. Inst of Civ Engrs—No. 3793. No. 9756 N.

Ore Handling.

An Interesting Aerial Cableway and Ore-Handling Plant in New Caledonia. An illustrated description of the plant and account of the work it accomplishes. 2500 w. Sci Am Sup—Nov. 27, 1909. No. 9487.

Pneumatic Tubes.

Underground Pneumatic Postal Tubes. R. S. Bayard. Illustrated description of the small subways and mechanical system of sending mail long distances underground. 4000 w. Am Mach—Vol. 52. No. 44. No. 9122.

MISCELLANY.

Aeronautics.

Aerial Flight. F. W. Lanchester. This first lecture of a series discusses resistance and means of lessening it, and conditions governing the flight resistance. 5000 w. Jour Soc of Arts—Oct. 29, 1909. No. 9158 A.

The Aeroplane—A Retrospect and a Forecast. J. Bernard Walker. Specially reviews the work of Maxim, Langley, and the Wright brothers, with remarks on the future outlook. Ills. 5000 w. Am Rev of Revs—Nov., 1909. No. 9207 C.

Progress in Aeroplane Construction (Fortschritte auf dem Gebiete des Drachenfliegers). Joseph Hofmann. A review of recent machines and results. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—Oct. 23, 1909. No. 9702 D.

Principles and Construction of Aeroplanes. Ansbert Vorreiter. Trans. from *Zeit. des Ver. d. Ing.* Illustrated discussion of principal American and European types as regards general design and means of maintaining stability. 5500 w. Am Mach—Vol. 32. No. 47. No. 9643.

The Importance of Model Tests of Air Ships and Flying Machines and the Göttingen Plant for Making Such Investigations (Die Bedeutung von Modellversuchen für die Luftschiffahrt und Flugtechnik und die Enrichtungen für solche Versuche in Göttingen). L. Prandtl. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 16, 1909. No. 9734 D.

Power Requirements of Aeroplanes (Der Kraftbedarf eines Fliegers). Fritz Huth. Mathematical discussion. Ills. 2000 w. Motorwagen—Oct. 31, 1909. No. 9594 D.

Aeroplane Frames. Discusses the construction of biplanes and monoplanes. Ills. 3500 w. Engng—Nov. 5, 1909. No. 9275 A.

How an Aeroplane Is Built. Stanley Yale Beach. Illustrates and describes types now being built and successfully operated. 5000 w. Am Rev of Rev—Nov., 1909. No. 9208 C.

The Chauvière Aeroplane. Illustrated description of this machine, which employs a sail instead of fixed planes. 800 w. Engng—Nov. 12, 1909. No. 9473 A.

The Weights of Monoplanes and Biplanes. Editorial making comparison between the two types. 1500 w. Engng—Nov. 12, 1909. No. 9471 A.

The Farman Biplane. Illustrated detailed description of the aeroplane which holds the endurance record. 1800 w. Sci Am Sup—Nov. 20, 1909. No. 9422.

An Impression of the Bleriot Monoplane. A. B. Rigby. Gives impressions of this machine which crossed the English Channel. Ills. 1000 w. Cassier's Mag—Nov., 1909. No. 9308 B.

Santos Dumont's Latest Monoplane. Illustrated description, with working drawings of the machine and all its parts, and report of flights. 1500 w. Sci Am Sup—Nov. 13, 1909. No. 9206.

The Santos Dumont No. 20—"La Demoiselle." Illustrate description of the smallest of the aeroplanes and the methods of control. 2500 w. Am Mach—Vol. 32. No. 44. No. 9126.

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The Dirigible of Today. T. R. MacMechen and Carl Dienstbach. Illustrates and describes the construction and performance of lighter than air flying machines. 4000 w. Am Rev of Revs—Nov., 1909. No. 9209 C.

The Second Paris Aeronautical Salon. R. P. Hearne. An illustrated article describing types of monoplanes, biplanes, dirigibles, and engines. 2000 w. Sci Am Sup—Oct. 30, 1909. No. 8966.

International Exposition of Aerial Navigation (L'Exposition internationale de Locomotion aérienne). G. Espitallier. Describes the exhibits at the aeronautical exposition held at Paris, Sept. 25 to Oct. 17 1909. Ills. 6000 w. Génie Civil—Oct. 23, 1909. No. 9541 D.

The International Aeronautical Exposition in Frankfurt a. M. (Die internationale Luftschiffahrt- Ausstellung in Frankfurt a. M.). A. Vorreiter. Illustrated description of the exhibits. Serial. 1st part. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 2, 1909. No. 9729 D.

Results of Recent Aviation Meetings (Résultats des récentes Meetings d'Aviation). Brief review of the results at the Paris, Brescia, Berlin, Cologne, Frankfort, Doncaster, and Blackpool meetings. Ills. 3000 w. Génie Civil—Oct. 30, 1909. No. 9544 D.

The Vaniman Dismountable Metallic Shed for Dirigibles (Hangar métallique démontable, Système Vaniman, pour Ballons dirigeables). Describes a knock-down steel frame, designed for housing dirigibles with a mobile army. Ills. 2000 w. Génie Civil—Oct. 2, 1909. No. 9532 D.

See also Aeronautic Motors, under COMBUSTION MOTORS.

Gun Stresses.

Graphical Illustrations of Professor Kaiser's Theory on Calculating Stresses and Strains in Built-Up Guns. A. Bremberg. Aims to show the advantage of the graphical method when approaching a problem like gun-building. 1500 w. Engng—Oct. 29, 1909. Serial. 1st part. No. 9178 A.

Typewriters.

Evolution in Design, Manufacture and Uses of Typewriting Machines. Charles D. Rice. A review of the development. 3500 w. Jour Fr Inst—Nov., 1909. No. 9330 D.

MINING AND METALLURGY.

COAL AND COKE.

Alabama.

The Coosa Coalfield of Alabama. William F. Prouty. Brief account of this coalfield which is estimated to contain 80,000,000 tons of high-grade coal, explaining why it has not been developed. 800 w. Eng & Min Jour—Nov. 6, 1909. No. 9138.

Blasting.

Safety Precautions in Shot Firing. Henry M. Payne. Describes mining methods and details of the system of firing at the Dalton Mine Collieries, Ltd., England. 1200 w. Eng & Min Jour—Oct. 30, 1909. No. 8988.

Charcoal.

Modern Methods of Manufacturing Charcoal. Eugene Haanel. Illustrated description of plant, from a report on the Investigations of the Electric Furnaces at Domnarfvets, Sweden, 400 w. Ir & Coal Trds Rev—Oct. 22, 1909. No. 9113 A.

Coal Cutting.

The Siskol Coal-Cutter, Rock Drill and Hammer Drill. Illustrated descriptions. 2200 w. Col Guard—Nov. 12, 1909. No. 9467 A.

Coke Drawing.

See Coke Ovens, under COAL AND COKE.

Coke Ovens.

The Mitchell Patent Coke Oven. John Fulton. Describes a form of oven especially adapted for machine drawing of the coke and illustrates machines. 5000 w. Mines & Min—Nov., 1909. No. 9056 C.

Coking.

Making Smokeless Fuel from Western Coal. R. S. Moss. Discusses methods employed and their value. 3000 w. Min Wld—Nov. 13, 1909. No. 9300.

Coking By-Products.

The Direct Extraction of Ammonia from Coke-Oven Gases (Die direkte Gewinnung des Ammoniaks aus Koksofengasen). G. Hilgenstock. A description of an improved method of extracting by-products from coke-oven gases. Ills. 2000 w. Stahl u Eisen—Oct. 20, 1909. No. 9561 D.

Colorado.

Mining Coal in Southern Colorado. Kenneth S. Guiterman. Illustrated account of the model plant at Colorado, with the advanced systems of sprinkling and short firing in use. 5000 w. Eng & Min Jour. —Nov. 20, 1909. No. 9432.

Electric Power.

The Selection and Installation of Electric Cables in Collieries. W. R. Morton. Deals principally with the alternating three-phase system, considering the types of cables used, and their laying. 4000 w. Elect'n, Lond—Oct. 29, 1909. No. 9169 A.

Electricity in the Collieries of Messrs.

Arch. Russell, Limited. Illustrated detailed description of electrically equipped collieries in Scotland. The supply is on the three-wire system. 3300 w. Ir & Coal Trds Rev—Nov. 5, 1909. No. 9282 A.

The Electrification of the Ferndale Collieries. Extracts from paper by W. H. Patchell in the Pro. of the S. Wales Inst. of Engrs., illustrating and describing features of this important plant. 7000 w. Ir & Coal Trds Rev—Oct. 22 and 29, 1909. Serial. 2 parts. No. 9189 each A.

Electric Installations at the Mines of the Compagnie nouvelle des Mines de Portes et Sénéchas (Les Installations électriques de la Compagnie nouvelle des Mines de Portes et Sénéchas). Edouard Lacombe. Describes the surface and underground plant at these coal mines. Ills. 3700 w. L'Elecn—Oct. 30, 1909. No. 9522 D.

England.

The Navigation Collieries, Crumlin. Illustrated detailed description of the works at these new collieries. 3500 w. Ir & Coal Trds Rev—Nov. 12, 1909. No. 9481 A.

Explosions.

The Barometric and Temperature Conditions at the Time of Dust Explosions in the Appalachian Coal Mines. N. H. Manmakee. A study of the control of temperature and humidity in mine-air, so as to make a dust explosion impossible. 3000 w. Bul Am Inst of Min Engrs—Nov, 1909. No. 9360 F.

See also Testing Stations, under COAL AND COKE.

Formation.

Petroleums and Coals Compared in Their Nature, Mode of Occurrence and Origin. Eugene Coste. Address before the Min. Sec. Engng. Soc., University of Toronto. 3000 w. Ap Sci—Nov., 1909. No. 9602 C.

Mine Dust.

See Testing Stations, under COAL AND COKE.

Montana.

The Roundup Coal Mines of Montana. J. P. Rowe. Illustrates and describes recent development work in a promising field. 2200 w. Min Wld—Nov. 27, 1909. No. 9656.

Peat.

Peat and the Fuel Question. Gives a résumé of some recent developments. Ills. 1500 w. Elec Rev, N Y—Oct. 30, 1909. No. 9017.

Production.

Coal Production in the United States in 1908. Edward W. Parker. From Mineral Resources of the United States. 4000 w. Min Wld—Nov. 6, 1909. No. 9153.

Rescue Work.

General Instructions Relating to Rescue Work Issued by the Central Rescue Station of Lievin, Pas-de-Calais, France. 2000 w. Col Guard—Nov. 5, 1909. Serial. 1st part. No. 9272 A.

Liquid Oxygen for Rescue Work in Coal Mines. Alfred Gradenwitz. Illustrated description of the Claude apparatus and its use. 1500 w. Eng & Min Jour—Nov. 6 1909. No. 9139.

Recent French and English Rescue Apparatus (Neuere französische und englische Rettungsapparate). Gustav Ryba. Describes in detail the Tissot, Weg, Fleuss and Mandet-Vanginot apparatus. Ills. Serial. 1st part. 1300 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 9, 1909. No. 9567 D.

Safety Lamps.

The Safeness of Various Types of Safety Lamps. J. B. Marsaut. Illustrated comparison of the construction of different lamps, their method of operation, etc. 2500 w. Eng & Min Jour—Nov. 13, 1909. No. 9291.

Testing Stations.

The Liévin Testing Station (Die Versuchstation zu Liévin). Herr Hatzfeld. Illustrated description of this French station for the investigation of dust explosions. 4000 w. Glückauf—Oct. 9, 1909. No. 9572 D.

Transportation.

Transportation of Coal by Flume. Robert M. Magraw. Illustrated description of the plant of the Montana Coal & Coke Co., at Electric, Mont. Compares cost with tramway. 3500 w. Mines & Min—Nov., 1909. No. 9055 C.

United States.

The Conservation of Coal in the United States. Edward W. Parker. Suggestions regarding the necessity of some control of the coal mining industry and the prevention of waste. 3000 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9358 F.

Washing.

See Coal Handling, under MECHANICAL ENGINEERING TRANSPORTING AND CONVEYING.

Weathering.

The Weathering of Coal. Myers Brown. Considers the losses of fuel in storage and handling at coaling stations. 1000 w. Cassier's Mag—Nov., 1909. No. 9315 B.

Weighing.

A New Weighing Machine for the Prevention of False Weights in Coal Shipment (Ein neuer Wiegebalken zur Verhinderung falscher Wägungen beim Kohlenversand). Dr. Weise. Illustrated description. 1700 w. Glückauf—Oct. 16, 1909. No. 9574 D.

West Virginia.

Upper Potomac Coal Fields. H. H. Stock. Illustrates and describes some of the principal operations. 3500 w. Mines & Min—Nov., 1909. No. 9053 C.

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COPPER.

Arizona.

The Miami-Inspiration Ore-Zone. C. F. Tolman, Jr. Describes the geology of this minneralized region of Arizona, the copper ore-bodies, methods of mining, etc. Ills. 3500 w. Min & Sci Pr—Nov. 13, 1909. No. 9414.

Disseminated Chalcocite Deposits at Ray, Arizona. C. F. Tolman, Jr. Describes these deposits, their geology, and development. 2500 w. Min & Sci Pr—Nov. 6, 1909. No. 9243.

Australia.

The Many Peaks Copper Mine, Queensland. J. Bowie Wilson. Map, illustration, and description of this property. Low-grade silicious ore. 2500 w. Eng & Min Jour—Oct. 30, 1909. No. 8987.

Chile.

The Copper Mines & Smelting Works of Catemu, Aconcagua, Chile. F. A. Sundt. Describes the Los Mantos mine, and the La Poza smelting works. 1500 w. Min Jour—Oct. 30, 1909. No. 9175 A.

Industry.

The Statistical Position and Future of Copper. James Douglas. A careful study of the outlook in the copper trade. 800 w. Engineering Magazine—Dec., 1909. No. 9781 B.

Reverberatory Furnaces.

Experiments in Reverberatory Practice at Cananea, Mexico. L. D. Ricketts. Gives detailed results obtained in using a reverberatory furnace for smelting, both with coal and oil fuel. Ills. 4000 w. Inst of Min & Met, Bul 62—Nov. 11, 1909. No. 9762 N.

Smelters.

State Smelting Works. C. F. V. Jackson. Illustrated report on their establishment in Queensland, and on the State assistance in the sale and disposal of ores. 3000 w. Queens Gov Min Jour—Oct. 15, 1909. Serial. 1st part. No. 9449 B.

See also Chile, under COPPER.

Smelting.

Present Conditions at the Garfield Smelting Works. L. S. Austin. An account of defects overcome and changes introduced. 1200 w. Min & Sci Pr—Oct. 30, 1909. No. 9117.

Smelting Practice of the Tyee Copper Company. George W. Maynard. An illustrated account of practice at Ladysmith, British Columbia, with analyses of representatives ores, matter, and slags. 3500 w. Eng & Min Jour—Nov. 6, 1909. No. 9134.

See also Reverberatory Furnaces, under COPPER.

Tasmania.

Mount Balfour Copper Field, Tasmania. Hartwell Conder. Description of field with plan of leases. 2500 w. Aust Min Stand—Oct. 20, 1909. No. 9451 B.

GOLD AND SILVER.

Alaska.

Mining in the Fairhaven Precinct, Alaska. Fred F. Henshaw. Abstracted from Bul. 379, U. S. Geol. Survey. Map and account of operations and methods in this goldfield. 2200 w. Min Wld—Nov. 20, 1909. No. 9441.

Amalgamation.

The Electrochemical System of Amalgamation and Cyanidation. Elmer Ellsworth Carey. Explains a new process for saving wasted values, indicating the economic effects if it prove successful. 3000 w. Engineering Magazine—Dec., 1909. No. 9780 B.

Cobalt.

The Nipissing and La Rosa Amalgamation. Alex. Gray. Discusses the objects of this proposed combination. 1600 w. Min Wld—Oct. 30, 1909. No. 9030.

Colorado.

Mining in Georgetown Quadrangle. Josiah E. Spur, George H. Garrey, and Sydney H. Ball. Abstract of paper No. 63, U. S. Geol. Survey, giving the geology of the region, nature of the ores, methods of vein formation, and mineral deposition. 7500 w. Mines & Min—Nov., 1909. No. 9054 C.

Cyaniding.

The Extraction of Gold and Silver from Ore by the Cyanide Process. Percy E. Barbour. An explanation of the process and present practice in applying it. 4000 w. Jour Worcester Poly Inst—Nov., 1909. No. 9216 C.

A New System for Cyanide Treatment of Slimes. Ferdinand McCann. Read before the Mexican Inst. of Min. & Met. Proposes a system called the dilution system, recommending the Dorr continuous slime thickener, or any apparatus on the same principle. 2500 w. Min Wld—Nov. 6, 1909. No. 9150.

A Sketch of the Small Cyanide Plant as Erected and Worked in Rhodesia. F. J. Thomas. Describes these plants and their working. 3000 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1909. No. 9669 E.

A One Hundred Ton Modern Cyanide Plant. Charles C. Christensen. Illustrates and describes the process and machinery. 1500 w. Min Wld—Nov. 13, 1909. No. 9301.

See also Amalgamation, under GOLD AND SILVER.

Dredging.

See Crushing, under ORE DRESSING AND CONCENTRATION.

France.

Re-Discovering the Gold Mines of France. Etienne A. Ritter. An illustrated account of the opening of three old gold-mining districts, with production last year of about $1,200,000. 2500 w. Min Wld—Nov. 27, 1909. No. 9658.

We supply copies of these articles. See page 650.

Japan.

Gold Mining at Hoshino, Kiushiu, Southern Japan. H. Hunter. Gives some mining laws regarding foreigners operating mines, and describes briefly the mines and deposits. 3500 w. Min Jour—Nov. 13, 1909. No. 9460 A.

Mexico.

Annual Report of the El Oro Mining Company. Tables of costs and extraction in this mining district of Mexico. 1200 w. Eng & Min Jour—Nov. 6, 1909. No. 9135.

Nevada.

Geological and Physical Conditions of Tonopah Mines. Walter P. Jenney. Describes the geology of the region and the ore formation. Ills. 1500 w. Min & Sci Pr—Nov. 20, 1909. No. 9631.

New Mexico.

The Black Range Mining District, New Mexico. J. W. Wright. Gives the early history, present operating conditions, geology, and other information. Ills. 2500 w. Min Wld—Nov. 13, 1909. No. 9302.

New Zealand.

Problems in the Geology of the Hauraki Gold Fields, New Zealand. A. M. Finlayson. Discusses the alteration of the enclosing rocks, the causes of ore-shoots and ore-deposition, and the source of the gold and silver. 3500 w. Ec-Geol—Oct.-Nov., 1909. No. 9775 D.

Ontario.

Notes on the Rainy River District, Ontario. W. L. Fleming. An illustrated account of a Canadian gold camp where rich seams and pockets occur in connection with low-grade ore. 2500 w. Eng & Min Jour—Nov. 27, 1909. No. 9650.

Placers.

Art of Placer Piping. Dennis H. Stovall. Brief discussion of the work of an expert piper. Ills. 1000 w. Min & Sci Pr—Nov. 13, 1909. No. 9415.

Rand.

See Sorting, under ORE DRESSING AND CONCENTRATION.

South Dakota.

Low Operating Costs in the Black Hills. S. D. Jesse Simmons. An account of mining, crushing, and cyaniding ore for $1 a ton. Ills. 2000 w. Min Wld—Nov. 13, 1909. No. 9299.

Submarine Mining.

Submarine Gold Mining on the Alaskan Coast. M. I. Macdonald. Brief descriptions of methods and apparatus used and proposed for submarine mining. Ills. 1000 w. Min Wld—Nov. 20, 1909. No. 9438.

IRON AND STEEL.

Analysis.

Determining Sulphur in Steel. C. Gordon Mills. Illustrated description of a new form of apparatus for making sulphur determinations. 1000 w. Ir Age—Oct. 28, 1909. No. 9026.

Blast-Furnace Practice.

Calculation of Blast-Furnace Charges. Percy E. Barbour. Explains two methods illustrating the calculation of a charge. 1500 w. Min & Sci Pr—Nov. 13, 1909. No. 9416.

Metallurgical Formation of Slag in Melting Iron. M. Albutz. A study of the substances that produce slag as a natural product without adding any flux, and the quantity of flux necessary to make the slag fusible enough to be easily drawn off. 2000 w. Prac Engr—Oct. 29, 1909. No. 9171 A.

Wastes of Heat and Materials in Smelting Works. Herbert Lang. Discusses a method for heating the blast by slag, and considers the utilization of heat of jacket water. 4000 w. Eng & Min Jour—Nov. 6, 1909. No. 9137.

Blast-Furnace Slag.

The Manufacture of Portland Cement from Blast Furnace Slag at the Coltness Iron Company's Works. Illustrated description. 1800 w. Ir & Coal Trds Rev—Oct. 29, 1909. No. 9190 A.

British Empire.

Iron Ores of the Crown Colonies and Protectorates of the British Empire. A summary of what is known of these ores. 4800 w. Bul Imp Inst—Vol. VII. No. 3. No. 9484 N.

Cementation.

Cementation. Alfred Sang. Explains the theories of cementation, describing processes and present-day methods. 3800 w. Elec-Chem & Met Ind—Nov., 1909. No. 9004 C.

Cementation by Carbon (Sur la Cémentation par le Carbone). Léon Guillet and Charles Griffith. A report on an investigation of cementation by means of pure carbon, with a review of previous researches on the same subject. Ills. 4300 w. Rev de Métal—Oct., 1909. No. 9506 E + F.

Electro-Metallurgy.

The Perkins Process of Refining Steel. Illustrates a process depending upon the use of a composite electrode to take the place of the usual carbon or metal one in the ordinary arc furnaces. 1000 w. Ir Age—Nov. 18, 1909. No. 9379.

The Girod Furnace and the Electrical Smelting Works of the Paul Girod System. Dr. W. Borchers. Illustrated description. 3500 w. Min Jour—Nov. 13, 1909. No. 9462 A.

Lake Superior.

Notes on Caving System in Northern Iron Mines. Albert H. Fay. Illustrated description of practice on the Mesabi Range. 1500 w. Eng & Min Jour—Nov. 13, 1909. No. 9290.

Marquette-Range Caving Method. H. H. Stock. Illustrates and describes

methods employed in Lake Supreior region for mining soft iron ores. 5500 w. Mines & Min—Nov., 1909. No. 9052 C.

Open-Hearth.

See Steel Works, under IRON AND STEEL.

Quebec.

Report on the Iron Ore Deposits Along the Ottawa (Quebec Side) and Gatineau Rivers. Fritz Cirkel. A summary of the results of an investigation of the region named, with an appendix containing valuable data on the water-powers of the district. Ills. & Maps. 50000 w. Can Dept of Mines—No. 23. No. 9499 N.

Rolling Mills.

The Calibration of Rolls (Allgemeines über Walzlinie und Oberdruck). J. Puppe. Discusses some of the most difficult problems in roll calibration. Ills. 4000 w. Stahl u Eisen—Oct. 27, 1909. No. 9564 D.

Electrically Driven Reversing Ingot Roll Train of The Rhine Steel Works (Die elektrisch betriebene Umkehrblockstrasse der Rheinischen Stahlwerke). A number of letters by M. Langer and Georg Meyer in criticism and defense of the latter's article on this subject. 3500 w. Stahl u Eisen—Oct. 20, 1909. No. 9562 D.

Discussion on "Electric Control for Rolling Mill Motors," "Automatic Motor Control," "Function of Fly-wheels in Connection with Electrically Operated Rolling Mills," "Power Requirements for Rolling High Carbon Steel of Small Section," "Electric Power Problems in Steel Plants," "Rolling Mill Motors," "Electric Driven Rolling Mills." Frontenac, N. Y., June 30, 1909. 5000 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9343 F.

Features of the Design and Operation of Rolling Mill Motors and Their Accessories. W. Manktelow. Discusses the relative advantages of electric and steam drive for the rolls, the energy required; power for auxiliaries, types used, gearing and time of reversal, fly-wheel use and design. etc. 3500 w. Elec Rev, Lond—Nov. 5, 1909. No. 9263 A.

See also Engine Governing, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Silicocalcium.

Silicocalcium and its Use in Iron and Steel Production (Das Silicocalcium und seine Anwendbarkeit in Eisenhüttenwesen). Ed. Donath and A. Lissner. Describes the production and characteristics of this alloy, and its use in steel refining. Serial. 1st part. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—Oct. 2, 1909. No. 9566 D.

Steel Works.

The Works of the New York State Steel Co. Plan of this Buffalo plant, with description of the Talbot open-hearth system installed. 1500 w. Ir Trd Rev—Nov. 25, 1909. No. 9619.

The Buderus Steel Works at Wetzlar (Die Buderus'schen Eisenwerke zu Wetzlar). Illustrated description of this three-furnace plant in Germany. 3200 w. Stahl u Eisen—Oct. 20, 1909. No. 9560 D.

LEAD AND ZINC.

Lead Assaying.

The Determination of Lead in Ores with the Aid of the Centrifugal Agitator (Die Bestimmung des Bleies in Erzen mit Hilfe der Schleudermaschine). Franz Castek. Describes the method and gives results of a number of assays. Ills. Serial. 1st part. 3200 w. Oest Zeitschr f Berg- u Hüttenwesen.—Oct. 30, 1909. No. 9570 D.

Zinc Recovery.

A Method for the Recovery of Zinc from Solutions of Sulphate. William Cullen and G. F. Ayers. Describes a process for the recovery of zinc slimes. Discussion. 2500 w. Jour Chem, Met, & Min Soc of S Africa—Sept., 1909. No. 9670 E.

Zinc Smelting.

Electric Zinc Smelting. Information concerning the Côte-Pierron process, as given in a paper by Eugène Fleurville, published in *La Houille Blanche*. Ills. 5000 w. Elec-Chem & Met Ind—Nov., 1909. No. 8998 C.

MINOR MINERALS.

Antimony.

See Arsenic, under MINOR MINERALS.

Arsenic.

Separation of Arsenic and Antimony by Means of Knorr Distillation Apparatus. Walter C. Smith. Describes the method devised by A. E. Knorr. Ills. 1200 w. Eng & Min Jour—Nov. 27, 1909. No. 9649.

Asbestos.

The Asbestos Industry of Quebec, Canada. Alexander Gray. Gives information concerning the deposits, their exploitation and development. 2200 w. Min Jour —Nov. 6, 1909. No. 9265 A.

Cement.

See Blast-Furnace Slag, under IRON AND STEEL.

Mercury.

Condition of the Quicksilver Industry in Texas. William B. Phillips. Information relating to the Terlingua district, the production, furnaces operated, fuel, etc. 3500 w. Eng & Min Jour—Nov. 20, 1909. No. 9433.

Quicksilver Deposits of Brewster County, Tex. Charles A. Dinsmore. Illustrated description of the works, with information in regard to the deposits. 1200 w. Min Wld—Oct. 30, 1909. No. 9028.

Quicksilver at Huancarelica, Peru. Lester W. Strauss. Reviews the history of the development of these deposits.

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Ills. 4500 w. Min & Sci Pr—Oct. 23, 1909. No. 9022.

The Product of Furnace III of the Imperial Quicksilver Works in Idria (Rohstupp vom Schüttofen Nr. III der k. k. Quecksilberhütte in Idria). F. Janda. Discusses certain features of quicksilver smelting at these Austrian works. 2800 w. Oest Zeitschr f Berg- u Hüttenwesen —Oct. 16, 1909. No. 9568 D.

Oil.

On the Origin of Petroleum. Leonard V. Dalton. An examination of the theories advanced, concluding that the greater part of the origin material came from marine life. 8800 w. Ec-Geol—Oct.-Nov., 1909. No. 9774 D.

Crude Petroleum (Pétroles bruts). J. Chaussin. A review of its production, properties, refining, products, etc. 3700 w. Rev d'Econ Indus—Oct. 16, 1909. No. 9501 D.

Drilling for Oil in Eastern Illinois. R. S. Blatchley. Information in regard to the development of these oil fields. Ills. 3800 w. Min & Sci Pr—Nov. 6, 1909. No. 9241.

Pumping and Shipping Oil in Eastern Illinois. R. S. Blatchley. Illustrated detailed description of methods adopted in developing this field and preparing the oil for market. 2500 w. Min & Sci Pr—Nov. 20, 1909. No. 9629.

See also Formation, under COAL.

Sapphires.

Development of Montana's Sapphire Mines. J. P. Rowe. Describes what are said to be the greatest sapphire mines in the world, and the mining methods. Ills. 1500 w. Min Wld—Nov. 6, 1909. No. 9151.

Tin.

The Great Pyramid Tin Mine (T.). Extracts from a report by E. W. Bonwick. Discusses the best method of sampling. Ills. 2000 w. Aust Min Stand—Oct. 13, 1909. No. 9450 B.

MINING.

Accounting.

A Method of Calculating Sinking-Funds, and a Table of Values for Ordinary Periods and Rates of Interest. J. B. Dilworth. An explanation of the problem, giving table. 900 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9361 F.

Air Compressors.

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Boring.

Methods of Boring and Limits of Research. W. A. J. M. Van Waterschoot van der Gracht. Gives a short description of the hydraulic Raky system in the present number, discussing its limitations. 3000 w. Min Jour—Nov. 13, 1909. Serial. 1st part. No. 9461 A.

Caving System.

See Lake Superior, under IRON AND STEEL.

Channeling Machines.

A Duplex Channeling Machine for Rock Cutting. Illustrated description of a machine having two gangs of cutters under the control of one operator, arranged to strike alternate blows. 1000 w. Eng News—Nov. 18, 1909. No. 9400.

Costs.

See South Dakota, under GOLD AND SILVER.

Drilling.

Drilling in Alluvial Ground in Alaska. T. A. Rickard. An account of the use of the drill in prospecting. Ills. 1700 w. Min & Sci Pr—Oct. 23, 1909. No. 9021.

Drills.

An Investigation of the Efficiency and the Employment of Air Drills in Mines (Expériences sur le Rendement et le Mode d'Emploi des Marteaux à Air comprimé dans les Mines). Results of recent tests made in France, abstracted from the *Bul. de la Soc. de l'Industrie Minérale.* 3000 w. Génie Civil—Oct. 9, 1909. No. 9538 D.

Electric Hoisting.

Safety Apparatus in Electric Hoisting Plants (Sicherheitsvorrichtungen an elektrischen Fördermaschinen). Herr Philippi. Describes a number of apparatus for ensuring the safety of the machinery and of hoisting. Ills. 4400 w. Glückauf —Oct. 16, 1909. No. 9573 D.

Explosives.

Explosives in the United States During the Last Three Years. Charles E. Munroe. Read at the Int. Cong. of Ap. Chem. Reviews the progress of the explosives industry. 4500 w. Min & Sci Pr—Nov. 20, 1909. No. 9630.

National Explosives Company, Limited, London, and Hoyle, Cornwall. An illustrated description of the manufacture of explosives for mining purposes. 4500 w. Col Guard—Nov. 5, 1909. No. 9271 A.

Hoisting.

Safety Cage Gear. Illustrated detailed description of Bennett's suspending and releasing gear for preventing overwinding. 1000 w. Ir & Coal Trds Rev—Nov. 19, 1909. No. 9694 A.

See also Wire Rope, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Hoisting Engines.

Speed-Controlling Devices for Winding Engines. Illustrates and describes various appliances for the prevention of overwinding. 4500 w. Mech Engr—Nov. 19. 1909. No. 9681 A.

Steam Brakes and Steam Reverses for Winding Engines. Severin Nelson. Briefly reviews the mechanical development of speed brakes, illustrating the

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steam brakes introduced by T. Pasfield. 1500 w. Mech Wld—Nov. 19, 1909. Serial. 1st part. No. 9683 A.

Power Plants.

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Prospecting.

See Drilling, under MINING.

Quarrying.

See Stone Crushing, under CIVIL ENGINEERING, CONSTRUCTION.

Reports.

Free-Hand Sketching with Mining Reports. Arthur Lakes. Shows the value of sketches. Ills. 1000 w. Min Wld—Oct. 30, 1909. No. 9029.

Shafts.

Technical Explanation of the Hoffmann Coefficient in the Chastelain Formula (Theoretische Erklärung des Hoffmannschen Koeffizienten zur Chastelainschen Formel). L. Herwegen. A mathematical discussion of the application of the formula to the design of shaft tubbing. Ills. 2000 w. Glückauf—Oct. 2, 1909. No. 9571 D.

See also Waterproofing, under CIVIL ENGINEERING, CONSTRUCTION.

Shaft Sinking.

Deep Sinking on the Bulli Coal Seam in Sydney. J. C. L. Rae. Read before the N. Engng Inst., N. S. W. Describes some of the work carried out in the equipment of the Sydney Harbor Colliery, especially this deep shaft sinking. 4500 w. Aust Min Stand—Sept. 29, 1909. Serial. 1st part. No. 9161 B.

Sociology.

See Welfare Work, under INDUSTRIAL ECONOMY.

Tramways.

The Boston Consolidated Tram. Louis S. Cates. Illustrated description of a tramway to deliver 3000 tons of ore per day from a mountain top to the railroad 737 feet below by means of a steep inclined plane. 3500 w. Mines & Min—Dec., 1909. No. 9880 C.

Tunnels.

The Roosevelt Deep Drainage Tunnel, Colorado. Rufus M. Bagg, Jr. Explains methods of mining and blasting, the progress made, etc., in the construction of this tunnel in the Cripple Creek district. 1500 w. Eng & Min Jour—Nov. 27, 1909. No. 9648.

Ventilation.

Ventilating-System at the Comstock Mines, Nevada. George J. Young. A detailed account of the system of ventilation at present in use at the Comstock mines. 12500 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9357 F.

ORE DRESSING AND CONCENTRATION.

Crushing.

Natomas 1500-Ton Plant for Crushing Dredge-Tailing. George Bowers. Illustrated detailed description of plant at Fairbanks, California, which has cleared away the rock-tailing piles, and utilized the material, beside restoring the land to cultivation. 1800 w. Min & Sci Pr—Nov. 6, 1909. No. 9240.

Drying.

A Theoretical Study of the Efficiency of Direct Heat Dryers. John Jermain Porter. Gives calculations for parallel current dryers, counter current dryers, and intermittent dryers. 3300 w. Elec-Chem & Met Ind—Nov., 1909. No. 9003 C.

Elmore Process.

The Elmore Vacuum Process of Mineral Concentration and its Results (Le Procédé Elmore d'Enrichissement des Minerais par le Vide et ses Résultats industriels). L. Descroix. A general review. Ills. 3500 w. Rev de Métal—Oct., 1909. No. 9509 E + F.

Gold Milling.

Milling Methods at Grass Valley, California. A. H. Martin. An illustrated article describing the practice at the mills of this district. 2000 w. Min Wld—Dec. 4, 1909. No. 9903.

See also South Dakota, under GOLD AND SILVER.

Jigs.

Wooden Jig Grates in the Joplin District. Otto Ruhl and Frank Sansom. Illustrates and describes the construction of the wooden grate used, explaining its advantages, and stating cost. 900 w. Eng & Min Jour—Nov. 20, 1909. No. 9434.

Lead Milling.

Ore Dressing in the Coeur d'Alene District. Edward S. Wiard. The first of a series of illustrated articles dealing with the metallurgical practice of the silver-lead mills. 4000 w. Eng & Min Jour—Nov. 27, 1909. No. 9647.

Sampling.

Preparing and Recording Samples for Use in Technical Assay Laboratories. Louis D. Huntoon. States the requirements and describes methods adopted. 2000 w. Bul Am Inst of Min Engrs—Nov., 1909. No. 9359 F.

Silver Milling.

Concentration at the Silver Mines of Caylloma, Peru. C. M. Carroll. Describes practice and gives results obtained. 1000 w. Min Jour—Oct. 23, 1909. No. 9102 A.

Slimes Treatment.

See Cyaniding, under GOLD AND SILVER.

Sorting.

Some Facts and Figures of Sorting on the Rand. L. D. Huntoon. Report of the increased efficiency by double sizing. 2000 w. Eng & Min Jour—Nov. 27, 1909. No. 9652.

Stamp Mills.

The Development of Heavy Gravitation

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Stamps. W. A. Caldecott's paper is discussed. 7000 w. Inst of Min & Met, Bul. 62—Nov. 11, 1909. No. 9761 N.

Some of the Details of Stamp Mills and Milling. Algernon Delmar. A critical discussion of details in stamp mills. Ills. 1600 w. Min Wld—Nov. 20, 1909. No. 9440.

Massey's Friction Drop-Stamps. Illustrated description of the apparatus and its action. 700 w. Engng—Nov. 19, 1909. No. 9688 A.

Tailings Conveyors.

Handling Stamp Mill Tailings by Belt Conveyors. Illustrates and describes the system used in the Michigan copper district, giving applications at a number of mills. 1700 w. Eng News—Oct. 28, 1909. No. 8983.

MISCELLANY.

Carborundum.

See Foundry Materials, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Forest Service.

The Forest Service and Mining in the National Forests. W. W. Dyar. Abstract of address before the Am. Min. Cong. A discussion of the work of the Forest Service as affecting the mining interests. 5000 w. Min & Sci Pr—Nov. 6, 1909. No. 9242.

Injurious Effect of the Forest Service on Mining. Russell L. Dunn. A communication to committee of Am. Min. Cong. appointed to investigate effect of Nat. Forest Service upon the mining industry. 3500 w. Min Wld—Nov. 6, 1909. No. 9152.

Korea.

Korean Mining. Information concerning the mining industries and methods, mining laws, etc. 3500 w. Min Jour—Oct. 23, 1909. No. 9101 A.

Mexico.

Important States of Central and Southern Mexico. H. A. Horsfall. Maps and account of parts of the country of interest to capitalists. 1500 w. Eng & Min Jour—Oct. 2, 1909. No. 8273.

The Instituto Geologico de Mexico. Jose G. Aguilera. Illustration and brief account of a government undertaking for the investigation of geologic and seismic phenomena. 1500 w. Eng & Min Jour—Oct. 30, 1909. No. 8985.

Newfoundland.

Mineral Resources of Newfoundland. Brenton Symons. Describes the conditions, climate, geology and mines of the island, giving information relating to its industries. 4000 w. Min Jour—Oct. 30, 1909. No. 9173 A.

Ore Deposits.

The Solidification of Alloys and Magmas. James Aston. Considers the possible analogies, comparing the alloys and igneous rocks from the standpoint of isomorphism and eutexia. Ills. 4000 w. Jour of Geol—Sept.-Oct., 1909. No. 8501 D.

Ozark Lead and Zinc Deposits; Their Genesis, Localization, and Migration. Discussion of the paper of C. R. Keyes. 2500 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8762 F.

The Mode of Filling of Some Mexican Ore Deposits. Juan D. Villarello. Detailed description of the ore deposits and of the probable mode of filling. 1800 w. Min Jour—Oct. 30, 1909. Serial. 1st part. No. 9174 A.

See also Arizona, under COPPER.

Ores.

What Is An Ore? J. F. Kemp. Gives a variety of definitions of an ore, discussing them critically. 2000 w. Can Min Jour—Nov. 15, 1909. Serial. 1st part. No. 9436.

Philippine Islands.

The Mineral Resources of the Philippine Islands, with a Statement of the Production of Commercial Mineral Products During the Year 1909. Report of nonmetallic Minerals by Warren D. Smith; metallic minerals, by H. G. Ferguson; raw cement materials, by A. J. Cox; gold fields, by Maurice Goodman; and structural materials, by George J. Adams. Ills. 12000 w. Bureau of Sci, Manila—1909. No. 8507 N.

Refractory Materials.

Heat Conductivity of Fire Brick. V. F. Dewey. An account of experiments made by the writer and his associates. Discussion. 4500 w. Pro Age—Oct. 1, 1909. No. 8243.

A New Refractory Material. Jos. W. Richards. Describes deposits of moler, in Denmark, and the bricks made from it. Ills. 800 w. Elec-Chem & Met Ind—Nov., 1909. No. 9000 C.

Siberia.

Conditions in the Urals. F. W. Draper. Information concerning the mining developments, labor conditions, difficulties and opportunities. 1500 w. Eng & Min Jour—Oct. 16, 1909. No. 8720.

Taxation.

Natural Taxation of Timber and Mining Land. Robert B. Brinsmade. Aims to show that such valuation is practicable. 2000 w. Min Wld—Nov. 29, 1909. No. 9442.

Transportation.

The Influence of the Railroads of the United States and Canada on the Mineral Industry. Discussion of James Douglas' paper on this subject. 1500 w. Inst of Min & Met, Bul. 62—Nov. 11, 1909. No. 9760 N.

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RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Accidents.

Collision at Jersey City, November 6. An account of a collision between a passenger train and empty engine, believed to be due to a false indication of the interlocking system. Gives testimony from an investigation made. Ills. 1800 w. R R Age Gaz—Nov. 26, 1909. No. 9644.

Accident Bulletin No. 32. A review of the report of the Interstate Commerce Commission for the three months ending June 30, 1909. 3000 w. R R Age Gaz—Nov. 19, 1909. No. 9418.

Dispatching.

Telephone Train Dispatching on the Seaboard Air Line. Illustrates and describes the apparatus. 1500 w. Ry & Engng Rev—Oct. 30, 1909. No. 9034.

Signalling.

Electro-Pneumatic Interlocking. W. B. Kouwenhoven. Describes this system. 2500 w. Ry & Loc Engng—Nov., 1909. No. 9063 C.

The Moving of Signal Cabin "A" at Utrecht Central Station. A. A. Boon. Illustrates and describes the operation. 3500 w. Bul Int Ry Cong—Oct., 1909. No. 9387 G.

Luminous Repeating Signals for Fog on the Brussels-Antwerp Line. L. Weissenbruch and J. Verdeyen. A detailed description of the system and its application to the fast traffic line of this road. Ills. 9300 w. Bul Int Ry Cong—Oct., 1909. No. 9382 G.

MOTIVE POWER AND EQUIPMENT.

Accelerometer.

A New Accelerometer. Considers briefly the nature of the problem and value of the instrument, and gives an illustrated description of Wimperis' accelerometer. 1200 w. Engr, Lond—Nov. 19, 1909. No. 9690 A.

Air Brakes.

Improvements in the Vacuum Brake. Illustrated description of the improved apparatus. 2000 w. Engng—Oct. 29, 1909. No. 9182 A.

Correcting Air Pressures. Remarks on the adjusting of air brakes after cleaning or repairing. Ills. 2300 w. Ry & Loc Engng—Nov., 1909. No. 9062 C.

Electrification.

A Study of the Possibility of Supplying Electric Power for the Railways of Java (Inlaiding tot de Studie van het hydro-electrische Vraagstuk betreffende de Spoorwegen op Java). J. K. Lagerwey. An examination of the hydraulic power available. Ills. 12500 w. Ingenieur—Oct. 2, 1909. No. 9739 D.

Inspection.

20th Century Inspection, or Run, Repair, or Transfer. William Baird. Abstract of paper, with discussion. 22500 w. Pro W Ry Club—Oct. 19, 1909. No. 9325 C.

Locomotive Boilers.

Some Practical Notes on Locomotive Boilers. C. Hugh Sumner. Notes on modern practice in firebox and boiler construction. Ills. 1500 w. Mech Wld—Nov. 5, 1909. No. 9267 A.

Improvements in Locomotive Boilers. (Question VI for discussion at the 8th session of the Railway Congress.) H. Fowler, and L. Archbutt. Report (No. 2) for Australasia, Great Britain, India, and South Africa. Ills. 21000 w. Bul Int Ry Cong—Oct., 1909. No. 9383 G.

Recent Types of Fireboxes for Locomotive Boilers (Types récents de Foyers pour Chaudiéres de Locomotives). M. Emanaud. Discusses particularly the Brotan water-tube boiler. Ills. 2500 w. Génie Civil—Oct. 2, 1909. No. 9534 D.

Locomotive Feed Water.

Water-Pick-Up Apparatus for Tank-Engines; L. and Y. Railway. Illustrated description of apparatus for enabling tank-engines to take water while running. 600 w. Engng—Nov. 5, 1909. No. 9276 A.

Locomotive Fuels.

The Utilization of Fuel in Locomotive Practice. W. F. M. Goss. Discusses tests of the U. S. Geol. Survey in relation to problems of combustion in locomotive boilers, also describing plant and locomotive. Ills. 5000 w. U S Geol Survey—Bul. 402. No. 9323 N.

Best Accounting Method for Railway Fuel. From a committee report to the International Railway Fuel Assn. 2500 w. R R Age Gaz—Nov. 5, 1909. No. 9128.

Locomotive Power.

Locomotive Tractive Effort Table. Gives table showing tractive power per pound of mean effective pressure, with brief note. 1000 w. R R Age Gaz—Nov. 5, 1909. No. 9127.

Locomotive Resistance.

The Frictional Resistance of Steam Locomotive Running with Closed Throttle. Editorial on tests reported by Cary T. Hutchinson in a paper before the Am. Inst. of Elec. Engrs. 2000 w. Eng News Nov. 18, 1909. No. 9402.

Locomotives.

Latter-Day Developments of the American Locomotive. H. Keith Trask. This second article considers superheating, feed-heating, boiler design, and valve mo-

We supply copies of these articles. See page 650.

tions. Ills. 4500 w. Engineering Magazine—Dec., 1909. No. 9783 B.

British Locomotive Practice. Aubrey F. Inglefield. Illustrated review of noted locomotives representing British modern practice. 1600 w. Ry & Loc Engng—Nov., 1909. No. 9064 C.

Locomotive with Water Tube Boiler. Brief illustrated description of a new type of engine with a water-tube boiler, a superheater, and rotary distribution valves. 500 w. Engr, Lond—Oct. 22, 1909. No. 9111 A.

Consolidation Locomotive with Superheater. Illustrations, elevations, cross-sections, and detailed description of engines for the Canadian Pacific Ry. 2500 w. Am Engr & R R Jour—Nov., 1909. No. 9009 C.

Mallet Locomotives for the Atchison. Illustrated description of new engines for passenger and freight service, with editorial. 4000 w. R R Age Gaz—Nov. 26, 1909. No. 9646.

Mallet Articulated Passenger Locomotives for the A., T., & S. F. Ry. Illustrated detailed description of these heavy passenger engines, with 4-4-6-2 wheel arrangement. 1500 w. Ry & Engng Rev—Nov. 6, 1909. No. 9156.

Mallet Articulated Compound Locomotives for the Eastern Railway of France. Illustrated description and general information. 1500 w. R R Age Gaz—Nov. 19, 1909. No. 9419.

Four-Cylinder Simple Balanced Locomotives, C., R. I., & P. Ry. Illustrated detailed description of a simple balanced engine using superheated steam, designed for high speed passenger service. 2000 w. Ry & Engng Rev—Nov. 20, 1909. No. 9443.

Ten-Wheel Locomotives for Brazil. Illustrates and describes two recent designs built for Brazilian roads. 700 w. R R Age Gaz—Oct. 29, 1909. No. 8991.

Articulated Locomotive for the Tasmanian Railways. Illustrations, with description of the Garratt locomotive, calling attention to features of interest. 900 w. R R Age Gaz—Nov. 12, 1909. No. 9245.

Garratt Locomotive. Brief illustrated description of an articulated locomotive for the Tasmanian Government railway, designed to work on grades of 1 in 25 with curves of 1½ chains radius on a road of 2 ft. gauge. 400 w. Ry & Loc Engng—Nov., 1909. No. 9061 C.

Locomotive Superheaters.

Test of the Jacobs Superheater on the Santa Fe. Illustrated report of tests showing economy effected. 500 w. R R Age Gaz—Oct. 29, 1909. No. 8993.

Locomotive Valve Gears.

The Baker-Pilliod Valve Gear as Applied to Locomotives. James Kennedy. Illustrated description of its construction and adjustment. Also discussion. 6500 w. Pro N Y R R Club—Oct. 15, 1909. No. 9380.

Lubricants.

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Motor Cars.

Superheated Steam Locomotives. Brief illustrated description of two German superheated motor-coaches. 800 w. Sci Am Sup—Nov. 20, 1909. No. 9423.

Motor Cars in General Railway Operation and Particularly on Local and Light Railways (Ueber den Automobilismus—Selbstfahrwesen—im Verkehre auf Eisenbahnen im allgemeinen und insbesondere auf Lokalbahnen und Kleinbahnen). E. A. Ziffer. A review of motor-car practice throughout the world. Ills. Serial. 1st part. 8500 w. Mit d Ver f d Förd d Lokal u Strassenbahnwesens—Sept., 1909 No. 9556 F.

Passenger Cars.

Double Open Diagonal Truss for Steel Passenger Cars. Arthur E. Heffelfinger. Analytical and graphical analysis. 2000 w. Am Engr & R R Jour—Nov., 1909. No. 9010 C.

Sanding Devices.

Automatic Sanding Apparatus for the Westinghouse Brake. S. Brütsch. Illustrated description. 950 w. Bul Int Ry Cong—Oct., 1909. No. 9386 G.

Shops.

Shops of the New Orleans Great Northern R. R. at Bogalusa, La. Illustrated detailed description of recently completed locomotive and car repair shops. 5000 w. Ry & Engng Rev—Nov. 27, 1909. No. 9655.

Scranton Shops of the Delaware, Lackawanna & Western. George L. Fowler. Illustrated description of the new shops in course of erection and their equipment. 5000 w. R R Age Gaz—Nov. 5, 1909. No. 9129.

Modern Manufacture of Car Wheels and Axles (La Fabrication moderne des Traines de Roues). G. Brunon. A review of modern machinery and practice for railroad shops. Ills. Serial. 1st part. 3000 w. Rev Indus—Oct. 2, 1909. No. 9530 D.

Tires.

See Rails, under PERMANENT WAY AND BUILDINGS.

Train Lighting.

Electric Lighting on Trains. A. Robb. Abstract of a report by the electrical engineer of the Bengal & N-W. Ry. Detailed description of the system used. 1500 w. Elec Engr, Lond—Nov. 5, 1909. No. 9261 A.

Electric Train Lighting (Ueber elektrische Zugbeleuchtung). Max Büttner.

We supply copies of these articles. See page 650.

An exhaustive review of systems in Europe and America. Serial. 1st part. 5500 w. Elek Kraft u Bahnen—Oct. 4, 1909. No. 9720 D.

Train Resistance.

Determination of Train Resistance. E. I. Wenger. An account of the experiments undertaken by the Railway Engineering Department of the University of Illinois. Ills. 2500 w. Can Soc of Civ Engrs—Oct. 28, 1909. No. 9212 N.

Trucks.

An Extensible Truck for Railway Cars (Bogies extensibles pour Matériel roulant à Voie normale et à Voie de 1 Mètre). Describes a truck used on Chinese railways which can be employed on both standards and metre-gauge lines. Ills. 1600 w. Génie Civil—Oct. 2, 1909. No. 9533 D.

Wheels.

See Shops, under MOTIVE POWER AND EQUIPMENT.

NEW PROJECTS.

England.

The Ashendon-Aynho Railway. Illustrated description of this new route of the Great Western Railway to obtain a shorter line to Birmingham and the North. 2000 w. Engr, Lond—Oct. 22, 1909. No. 9110 A.

Transandine.

The Transandine Railway. T. H. Minshall. Illustrated article describing the line and discussing traffic prospects. 1200 w. R R Age Gaz—Nov. 12, 1909. No. 9246.

PERMANENT WAY AND BUILDINGS.

Bridge Inspection.

See Inspection, under CIVIL ENGINEERING, BRIDGES.

Coaling Plants.

Railroad Coaling Stations and Cinder Pits. Abstract of the report of committee of the Am. Ry. Bridge and Building Assn., describing types. 2500 w. Eng Rec—Nov. 6, 1909. No. 9146.

Crossings.

Grade Crossing Elimination in Worcester, Mass. Illustrates and describes changes made necessary, including the elevation of about 20 ft. of over four miles of railroad, a new station, change of grade of 15 streets, and the construction of three new streets. 1800 w. Eng Rec—Oct. 30, 1909. No. 8973.

Curve Tables.

The Southern Pacific Taper Curve Tables, and Their Use with the Traverse Method. William Clyde Willard. An explanation of the Taper Curve Tables of the Southern Pacific Railroad. 4000 w. Eng News—Oct. 28, 1909. No. 8979.

Elevated Railways.

The Arborway Section of the Boston Elevated Railway. Illustrated description of the concreting of girders and columns to improve the appearance. 2000 w. Eng Rec—Nov. 6, 1909. No. 9145.

See also Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Rail Creeping.

The Causes and Prevention of Rail Creeping (Die Schienenwandern, Ursache und Abhilfe). W. Kunze. Describes and discusses a number of types of construction and devices to prevent rail creeping. Ills. 2500 w. Glaser's Ann—Oct. 1, 1909. No. 9595 D.

Rails.

Tire and Rail. Sections of rails used on the Taff Vale system are given, with information as to tests, material, etc. Also sections of tires used on other railways, and points relating to them. 2500 w. Engr, Lond—Nov. 12, 1909. No. 9476 A.

See also Alloy Steels, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Stations.

How Much Ought American Railways to Spend on New Passenger Stations? Editorial discussion of the costly work in progress in New York and other cities. 2500 w. Eng News—Oct. 28, 1909. No. 8981.

TRAFFIC.

Car Supply.

Present Car Supply. Arthur Hale. Explains conditions and the present situation, discussing ways of increasing the efficiency of equipment. 2500 w. R R Age Gaz—Oct. 29, 1909. No. 8990.

Freight Claims.

New Method of Handling Freight Claims on St. Louis and San Francisco. Samuel O. Dunn. Explains the new method of handling claims for loss and damage to freight, and the results secured. 4000 w. R R Age Gaz—Nov. 12, 1909. No. 9247.

Freight Handling.

Handling Fast Merchandise on the St. Louis & San Francisco. Map and description of the method of handling. 3000 w. R R Age Gaz—Oct. 29, 1909. No. 8989.

See also same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

MISCELLANY.

Accounting.

Deferred Charges to Operating. Walter A. Staub. Considers the proper treatment of deferred charges to operating, and some of the abuses observed in common practice. 7000 w. Jour of Acc—Oct., 1909. No. 9218 C.

Austria.

The Tauern Railway. Illustrated detailed description of this Alpine railway, which is remarkable for the natural beauty. 4000 w. Engr, Lond—Nov. 12, 1909. No. 9477 A.

We supply copies of these articles. See page 650.

China.

Opening of the Peking-Kalgan Railway, the Gateway to Siberia. Emil S. Fischer. Letter to the editor giving an account of this event, with abstracts of addresses made. 2500 w. Ry & Engng Rev—Nov. 6, 1909. No. 9157.

Light Railways.

The Working of Light Railways (Question XVIII for discussion at 8th session of the Railway Congress). Mr. Plocq. Report. 9700 w. Bul Int Ry Cong—Oct., 1909. No. 9385 G.

South America.

The Madeira-Mamoré Railway. John Y. Bayliss. Describes briefly the Amazon and Bolivian waterways, and gives an illustrated account of this isolated railway around falls in the rivers named. 3500 w. Eng News—Oct. 28, 1909. No. 8978.

Valuation.

Valuation of Railway Properties. Robert Yates. Considers a few of the principal elements of construction, showing the cost value and depreciated value. 2000 w. R R Age Gaz—Nov. 19, 1909. No. 9420.

STREET AND ELECTRIC RAILWAYS.

Cable Railways.

Signal and Train-Telephone Equipment on Cable Railways (Streckensignal- und Zugstelephon-Ausrüstung auf Drahtseilbahnen). L. Kohlfürst. Describes devices applied on two cable railways in Austria. Ills. 2500 w. Schweiz Bau—Oct. 2, 1909. No. 9582 B.

Car Maintenance.

Car Maintenance on American Electric Railways (Einiges über Unterhaltung und Ausbesserung elektrischer Fahrzeuge amerikanischer Bahnen). Herr Domnick. A review and discussion of systems described in recent periodical literature. Ills. Serial. 1st part. Glaser's Ann—Oct. 15, 1909. No. 9596 D.

Cars.

Radial Axle, Single-Truck Car Seating Forty-six Passengers. Drawings and description. 7000 w. Elec Ry Jour—Oct. 9, 1909. No. 8514.

New Steel Cars of the Seattle, Renton & Southern Railway. Illustrates and describes cars built on rather original lines. 1000 w. Elec Ry Jour—Oct. 5, 1909. No. 8422.

Reconstruction and Standardization of Chicago Railway Company's Cars. Illustrated description of the rebuilding of double-end vestibule closed cars to fit them for pay-as-you-enter service. 3500 w. Elec Ry Jour—Nov. 27, 1909. No. 9618.

1200-Volt Current Car Equipment. F. E. Case. Appendix to report of Committee on Equipment, presented at Denver meeting of Am. St. & Int. Ry. Engng. Assn. Diagrams. 2000 w. Eng News—Nov. 4, 1909. No. 9075.

Chicago.

Phases in the Development of the Street Railways of Chicago. Bion J. Arnold, H. B. Fleming, and George Weston. A general statement of the work in progress, and discussion of car-house design and operation and the organization of the work. Ills. General discussion. 13800 w. Jour W Soc of Engrs—Oct., 1909. No. 9338 D.

Controllers.

Recent Developments in Railway Motor Control. Clarence Renshaw. Appendix to the report of the Committee on Equipment, Am. St. & Int. Ry. Engng. Assn. Diagrams. 2500 w. Eng News—Nov. 4, 1909. No. 9073.

Electric Traction.

A Criticism of the New High-Speed Traction System Devised by August Scherl (Kritik des neuen Schnellbahn-Systems von August Scherl). Wolfgang Adolf Müller. Discusses Scherl's proposals for a high-speed mono-rail system. 3700 w. Elektrotech u Maschinenbau—Oct. 24, 1909. No. 9725 D.

Interurban.

Interurban Electric Railways. Benjamin Franklin. Illustrated discussion of problems of location and construction of such railways. Short general discussion. 4500 w. Pro Engrs' Club of Phila, No. 1072—July, 1909. No. 9334 D.

Passenger and Freight Business of the New Jersey & Pennsylvania Traction Company. Map, giving the location of the lines and population of the communities served, with account of conditions and service. Ills. 2500 w. Elec Ry Jour—Nov. 20, 1909. No. 9409.

Locomotives.

Detroit River Tunnel Electric Locomotive. Illustrated detailed description. 2000 w. Engr, Lond—Nov. 5, 1909. No. 9279 A.

Detroit River Tunnel Locomotive. Illustrated detailed description. 2000 w. Ry & Loc Engng—Nov., 1909. No. 9060 C.

Pennsylvania Electric Locomotives. Illustrated detailed description of locomotives designed for use in the New York tunnels. 3000 w. R R Age Gaz—Nov. 5, 1909. No. 9131.

An Electric Locomotive Built on Steam Locomotive Lines: The Pennsylvania R. R. Type. Illustrated detailed descrip-

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tion of this direct-current locomotive. 2500 w. Eng News—No. 11, 1909. No. 9248.

Three-Phase Locomotives for the Simplon Railway (Die Drehstromlokomotiven für den elektrischen Betrieb am Simplon). W. Kummer. Illustrated detailed description. 3600 w. Schweiz Bau—Oct. 23, 1909. No. 9584 B.

The New Three-Phase, Four-Speed Locomotives of the Simplon Tunnel (Les nouvelles Locomotives triphasées à quatre Vitesses du Tunnel du Simplon). H. Marchand. Illustrated detailed description. 3500 w. Soc Belge d'Elecns—Oct., 1909. No. 9503 E.

Electric Locomotives of the Brünn Street Railways (Die elektrischen Lokomotiven der Brünner Strassenbahn). Fritz Gubler. Describes locomotives used for freight transportation. Ills. 2000 w. Elektrotech u Maschinenbau—Oct. 17, 1909. No. 9724 D.

A Chart of the Permissible Ratio of Car Weight to Locomotive Weight in Electric Trunk Line Operation under Various Conditions, and the Tractive Power and Locomotive Weight Required per Ton of Train Weight (Graphische Ermittlung des bei elektrischen Vollbahnen unter verschiedenen Betriebsumständen zulässigen Verhältnisses von Wagengewicht zu Treibgewicht sowie der erforderlichen Zugkraft und Leistung pro Tonne Zuggewicht). Ills. 2500 w. Elek Kraft u Bahnen—Oct. 4, 1909. No. 9719 D.

See also Three Phase, under STREET AND ELECTRIC RAILWAYS.

Long Island.

The First Cross-Island Electric Line on Long Island. An illustrated description of the recently completed line between Huntington Harbor and Amityville. 2000 w. Elec Ry Jour—Nov. 13, 1909. No. 9244.

Los Angeles.

Reconstruction and Improvements of the Los Angeles Pacific Company. P. H. Albright. Illustrated detailed description. 3500 w. Elec Ry Jour—Oct. 30, 1909. No. 9023.

Monorail.

The Brennan Monorail System. Brief account of a successful demonstration in England of a full-sized car. 1200 w. Elec Rev, N Y—Nov. 20, 1909. No. 9435.

The Brennan Mono-Rail System. Illustration of the full-size vehicle tested in England, with description and report of trial. 900 w. Engng—Nov. 12, 1909. No. 9472 A.

Railless.

First Trackless Trolley Car Around London. Illustrated description of the car and its equipment, especially the current-collecting device. 2000 w. Elec Rev, N Y—Oct. 30, 1909. No. 9020.

Rails.

See Track Construction, under STREET AND ELECTRIC RAILWAYS.

Shops.

New Car Repair Shops of the Oneida Railway Company at Syracuse, N. Y. Plans and illustrated description. 4000 w. Elec Ry Jour—Nov. 6, 1909. No. 9115.

Single Phase.

Hamburg (Germany) Single-Phase Suburban Traction System. Frank Koester. Illustrated description of the Blankenese-Ohlsdorf road, and its equipment. 3000 w. Elec Wld—Nov. 18, 1909. No. 9392.

Development of a Swiss Single-Phase Railway.—The Seebach-Wettingen Line. F. P. Mann. Describes this single-phase line for heavy railroading, as an example of the latest design of heavy electric traction in Switzerland. 4000 w. Eng News—Nov. 11, 1909. No. 9251.

The Felten un Guilleaume-Lahmeyerwerke System of Single-Phase Electric Traction (La Traction électrique par Courant alternatif simple sur les Chemins de Fer en Europe). M. Henry. Brief general description. Ills. 4000 w. L'Elecn—Oct. 23, 1909. No. 9521 D.

Subways.

The Applicability and Comparative Cost of Concrete and Reinforced Concrete for Subway Construction. Charles M. Mills. Shows the advantages of both plain and reinforced concrete for this work. Discussion. Ills. 2500 w. Pro Nat Assn of Cement-Users—1909. No. 9372 N.

Underground Railways in London. C. O. Burge. A brief general description of the two systems of underground roads, those similar to the N. Y. Subway, and the "tubes." Map. 3000 w. Eng Rec—Nov. 20, 1909. No. 9430.

Three Phase.

The Electric System of the Great Northern Railway Company at Cascade Tunnel. Cary T. Hutchinson. A general description of the first three-phase installation on a trunk line railway in the United States, with special reference to the electric locomotives, and a statement of the operation. Ills. 7000 w. Pro Am Inst of Elec Engrs—Nov., 1909. No. 9340 F.

Track Construction.

Rail Grooves and Track Gauge for Curved Tracks. C. W. L. Filkins. Method of determining the minimum groove, etc. Ills. 2500 w. Can Engr—Oct. 29, 1909. No. 9033.

Reconstruction of Street Car Tracks in Chicago. George Weston. Describes the different types of track construction adopted, the theory upon which the designs are based, and the materials. Ills. Discussion. 11500 w. Jour W Soc of Engrs—Oct., 1909. No. 9339 D.

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EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Chinese Wall.

The Great Wall of China. By William Edgar Geil. Size, 9 by 6 in., pp. xvi. 393. Ills., 116. Price, $5. New York: Sturgis & Walton Company.

An exhaustive study from personal investigation of the greatest engineering work of antiquity. The voluminous archeological, historical and structural data which Dr. Geil has incorporated in his narrative of a journey from end to end of the Great Wall lend to his book, in addition to its intrinsic fascination as a book of travel, the dignity of a treatise on a subject hitherto inadequately dealt with. The interest of the work is greatly enhanced by the excellence of the numerous illustrations.

Compressed Air.

Compressed Air Plant for Mines. By Robert Peele. Size, 9 by 6 in.; pp., xix, 325. Ills. Price, $3. 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Outside of a brief review of the fundamental principles of air compression, sufficient to make intelligible the formulæ employed for calculations of compressor power and capacity and for the solution of the problems of distribution and utilization, the author confines himself wholly to the practical aspects of his subject. The first part of the book presents a view of current practice in the construction and operation of compressors; the second is devoted to the applications to mine service of compressed air transmission of power, in drilling, pumping and haulage. The author acknowledges that most of his data are not original, but his compilation and arrangement of the information scattered through the files of technical publications should prove of value to those engaged in work involving the use of compressed air, and especially to those interested in its utilization in mining.

Ore Deposits.

A Study of Ore Deposits for the Practical Miner. By J. P. Wallace. Size, 9 by 6 in.; pp., xv, 343. Ills. Price, $3. New York and London: Hill Publishing Co.

A book written for the average miner, the prospector and the mining public, dealing with the essentials of economic geology in simple and concise language. An idea of its scope may be gathered from the headings of the five parts into which the thirty chapters are divided: The Ore Minerals; The Rock-Forming Minerals, Rocks and Rock Displacements; General Characters and Classes of Ore Deposits; Some Types of Ore Deposits; and Mine Valuation and Prospecting.

Pigments.

Modern Pigments and Their Vehicles. By Frederick Maire. Size, 7 by 5 in.; pp., xi, 266. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

An extremely practical work for the painter and decorator, giving a brief and concise history of all valuable pigments useful in painting, the main sources of their derivation and supply, their properties and chief uses, their good qualities and defects, and the best methods of detecting adulteration.

Reservoirs.

Reservoirs for Irrigation, Water Power and Domestic Water Supply. By James Dix Schuyler. Second Edition. Size, 10 by 7 in.; pp., xxvi, 573. Ills. Price, $5, 25/6. New York: John Wiley & Sons; London: Chapman & Hall.

In revising this well known work for its second edition, the author has attempted to bring it up to date by a review of the remarkable activity in dam and storage-reservoir construction since the beginning of the present century. Much new matter and over 230 new illustrations have been added and some obsolete data have been removed. The principal additions include large extensions to the chapters on hydraulic-fill and masonry dams, and two entirely new chapters on reinforced-concrete and structural-steel dams. The discussions of rock-fill and earth dams and of natural reservoirs have been brought up to date. An appendix gives tabulated data of the cost of reservoir construction per acre-foot in the United States and in foreign countries, and also tables of the area and capacity of twelve Western reservoirs at varying levels.